INFORMATION SOCIETIES TECHNOLOGY (IST) PROGRAMME

Contract for:

Shared-cost RTD

Annex 1 - "Description of Work"

Project acronym: **SAFIRA**
Project full title: **Supporting Affective Interactions for Real-time Application**
Contract no.: *(to be completed by Commission)*
Related to other Contract no.: *(to be completed by Commission)*

Date of preparation of Annex 1 (Ammendment): 9thth October 2001

Proposal number*:* **IST-1999-11683**
Operative commencement date of contract:
(to be completed by Commission)

1 Project Summary

Shared Cost RTD CPF Form – Form A2

EUROPEAN COMMISSION
RESEARCH DIRECTORATES
GENERAL
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Project Acronym [2]	SAFIRA	Proposal No [3]	IST-1999-11683

A2. Project Summary [20]

Objectives (maximum 1000 characters)

Main objective: to bring to the software community an enabling technology to support affective interactions.
Specific objectives:
1. To create a framework to enrich interactions and applications with an affective dimension.
2. To implement a toolkit for affective computing combining a set of components addressing affective knowledge acquisition, representation, reasoning, planning, communication and expression.
3. To verify under which conditions the hypothesis that emotion, as well as other affective phenomena, contributes to improve rationality and general intelligent behaviour of the synthetic characters, thus leading to more believable interactions between humans and computers.

Description of the work (maximum 2000 characters)

To achieve the main goal of SAFIRA we will research and develop along the three fundamental phases of affective computing:
1. The Affective Sensory for Autonomous Agents, where we will develop some affective sensing techniques mainly through the use of external objects (toys) and interpret the input from the user thought the development of techniques for affective user modeling.
2. Affective Reasoning, Planning and Learning, where the problem of embedding emotion and cognition in a machine (being it a synthetic character, an agent or even a robot) will be handled. This entails the development of techniques for affective planning, affective reasoning and decision making, personality and emotions development, learning and emergence.
3. Affective Communication and Expression, where new techniques for conveying emotions in a believable way will be developed.
These three parts form the core research and also the components that will become part of an emotion-based architecture. We will integrate these components in a general toolkit that can be used in any application to achieve affective interactions with the users. To illustrate this use we will develop a set of concept demonstrators. Such demonstrators will be test cases for the verification of which conditions the hypothesis that emotion, as well as other affective phenomena, contributes to improve rationality and general intelligent behaviour of the synthetic characters thus leading to more believable interactions between humans and computers.

Milestones and expected results (maximum 500 characters)

(M) Components for Affective Input, (M) Affective User Modeling, (M) Affective Decision Making, and Planning, (M) Emotional Enriched Body and Facial Expression, (M) Affective Graphics.
(M) Toolkit and Framework for Affective Computing.
Concept demonstrators:
(M) Influencing Machine, (M) Fantasy World (FantasyA), and (M) Affective Personal Assistant (James the Butler).
(M) Evaluation of affective interactions.

2 Project Objectives

The main objective of SAFIRA is to bring to the software community an enabling technology to support affective interactions.
Although emotions were, for a long time, considered undesirable for rational behaviour, there are now evidences in neuroscience and psychology that place emotions as an important factor in problem solving capabilities and intelligence in general [Damásio,94] [Sousa,87]. As a result, organisations use now **emotional intelligence** [Goleman,97] tests as an evaluation procedure, and a strong new field is emerging in computer science: **affective computing**, *i.e.* "computing that relates to, arises from or deliberately influences emotions" [Picard,97]. As humans interact directly with computers, it is critical for this interaction to be empowered with affective components that enrich it and make it more adequate for each individual user, but also provide "machine intelligence" with otherwise impossible capabilities. In the words of Minsky: "the question is not whether intelligent machines can have any emotions, but whether machines can be intelligent without emotions." [Minsky,85].
Based on these recent findings, SAFIRA addresses the resulting need to enrich the interaction between humans and computers with an affective dimension. We propose that such enrichment can be achieved through the provision of a framework and a toolkit that capitalise on recent research done on the area of affective computing and address the problem of building believable characters.
The main aim is to **bring to the software community an enabling technology to support affective behaviour and control in real-time multi-agent systems interacting with users.** These systems are real-time in the sense that emotional stimuli and responses are immediate and that emotional output can be used as emotional input to close the autonomous agents' loop.
We intend to create a set of basic demonstrators of the potential of such systems: 2D and 3D virtual environments shared by synthetic characters and users, and "anthropomorphised" personality-rich personal service assistant based applications. Those demonstrators will explore the concept of a virtual environment improved by an emotional channel seamlessly integrated with the audio-visual representation of the environment. Multi-sensory interaction between participants projected cyber-selves, other participant avatars and the autonomous agents inhabiting the environment will be the means to evaluate the models developed during the project. Besides the real impact of emotions on the overall virtual environment and interface, we will also assess whether and how personality defined agents prove to be more adequate in a culturally rich space as the European community.
Achieving our prime goal leads to the following scientific and technological issues:

Scientific Goals and Challenges

Rather than trying to explain human emotions, this project will create a framework for the use of a toolkit that will be used to enrich the current interaction software, and test its usability we a set of the basic demonstrators. To achieve such goal, we will need to research on diverse scientific areas that deal with theories, models, architectures and mechanisms by which emotion, affect and personality play a control role in obtaining intelligent behaviour.

Thus, the **research challenges** addressed during the duration of this project will include:
1. How do personality and emotions relate? How to build personality and emotion based software?
2. How do emotions affect the overall intelligent behaviour of autonomous agents? How do personality and emotions affect each different level of the synthetic beings (*e.g.* perception, planning, and learning)? How are emotions created and evolve? How does personality evolve?
3. How do personality and emotions affect the overall interaction? How to design personality based characters and interaction?

These research problems underlie the following set of **scientific objectives**:

1. To perform a preliminary comparative and integration study of current personality and emotion theories to be used for affective interactions *(this objective will be attained in tasks 2.1 in WP2 and 4.1 in WP4*
2. To create an overall framework to enrich interactions and applications with an affective dimension, based on the study performed in 1 *(this objective will be achieved through the execution of tasks 2.2 and 2.3).*
3. To study certain conditions under which the hypothesis that emotion, as well as other affective phenomena, contributes to improve rationality and general intelligent behaviour of the synthetic characters, lead to more believable interactions between humans and computers *(this objective will be achieved through the execution of WP6-demonstrators and WP7-evaluation)*
4. To create a usable preliminary set of computational models for emotion emergence, development and evolution, which allow the creation of synthetic personalities for autonomous agents *(this objective will be achieved through the execution of WP4, tasks 4.1, 4.2, 4.3 and 4.4)*
5. To disseminate our results and tools throughout the European community and the world, the present project aimed to be one of the main driving forces in the advances that will be taking place world wide in this area of research (this objective will be achieved through the task 1.2).

Technological Goals and Challenges

If research challenges address the conceptual framework, the **technological challenges** address issues related with the toolkit creation, including:

1. Which semi-independent components must be present in personality and emotion based applications?
2. How are the different components influenced by experienced emotions and defined personalities? How is "emotional information" carried over the several components in a consistent way?
3. How to use affect as a new dimension to enrich the interaction between machines and humans? How can synthetic autonomous agents exhibit a certain personality and clearly convey their emotional behaviour to users?

These technological problems underlie the following **technological objectives**:

1. To design a general framework for "affective" synthetic autonomous agent creation with a context and domain-free interface between the various independent architectural components, allowing the use of different models and theories *(this objective will be achieved through the execution of Task 2.3)*
2. To implement an instantiation of this interface over a set of components integrated in a toolkit addressing affective knowledge acquisition, representation, reasoning, planning, and communication. Communication will be performed using mechanisms such as facial and body expression and speech *(this objective will be achieved with the integration- in WP2, of components developed in WP3, WP4 and WP5).*
3. To build these elements in such a way that they can be used idiosyncratically, allowing the mapping of different personalities on to the autonomous agents built with them. *(this objective will be achieved through the execution of Task 4.4)*
4. To create mechanisms allowing the integration of affective components into systems interacting with human users and evaluate the actual impact of such enhanced interfaces through a set of demonstrators *(this objective will result from the real integration of the affective components in the demonstrators developed in WP6, and their evaluation done in WP7).*
5. To use external physical devices (toys) supplied with sensors allowing the capture of some emotional and behavioural aspects of the user *(this objective will be achieved through the execution of WP3)*

Application Goals

We will construct a small set of demonstrators. These demonstrators have a multifaceted role in this project:

- To prove experimentally the validity of the conducted research *(this evaluation objective will be realised through the tasks in WP 7).*
- To illustrate the use of the framework and toolkit in innovative and practical examples, where emotion and personality based autonomous agents play a fundamental role *(this objective will be achieved with the development of the demonstrators in WP6).*

Moreover, and due to the enormous impact that this work and research will have on several technological and social areas, we also plan to show with these small demonstrators the consequences that this research will have on other application areas and evaluate possible ethical issues involved.

References:

[Damásio,94] António Damásio: Descartes' Error, Avon Books, 1995.
[Goleman,97] Daniel Goleman: Emotional Intelligence, Bantam Books,1997.
[Minsky,85] Marvin Minsky: The society of Mind, Simon & Schuster, 1985.
[Picard,97] Rosalind Picard: Affective Computing, MIT Press, 1997.
[Sousa,87] R. de Sousa: The Rationality of Emotion, MIT Press, 1987.

3 List of Participants

Participant Role	Participant number	Participant name	Participant short name	Country	Status*	Date enter project	Date exit project
CO	1	Instituto de Engenharia de Sistemas e Computadores, Investigação e Desenvolvimento em Lisboa *	INESC-ID*	P	C	M7	M26
CR	2	Associação para o Desenvolvimento das Telecomunicações e Técnicas de Informática	ADETTI	P	P	M0	M26
CR	3	Deutsches Forschungszentrum fuer Kuenstliche Intelligenz	DFKI	D	P	M0	M26
CR	4	GMD - Forschungszentrum Informationstechnik GmbH	GMD	D	P	M0	M11
CR	5	The Imperial College of Science Technology and Medicine	ICSTM	UK	P	M0	M26
CR	6	Austrian Research Institute for Artificial Intelligence	OFAI	A	P	M0	M26
CR	7	Swedish Institute of Computer Science	SICS	S	P	M0	M26
CR	8	Instituto de Engenharia de Sistemas e Computadores *	INESC *	P	C*	M0	M6
CR	9	Fraunhofer Gesellschaft zur Foerderung der angewandten Forschung e. V.	FhG/IMK**	D	P	M11	M26

*C = Co-ordinator (or use C-F and C-S if financial and scientific co-ordinator roles are separate)
P - Principal contractor
A - Assistant contractor

- INESC (P8) and INESC-ID P1 are the same partner, it is only added for administrative purposes (legal status has changed). So in this document (P1) will referred to INESC or INESC-ID.
- ** GMD (P4) and FhD/IMK (P9) are the same partner, it is only added for administrative purposes. So, in this document P9 and P4 will be referred as GMD.

4 Contribution to programme/key action objectives

Affective computing is aimed at humanising large-scale Virtual Environments (VE's). This means having VE's that are not just fully functional in a rational way, but also comfortable for human beings and responsive to their moods and feelings.
Current trends demonstrate that VE's will be populated, not just by people, but also by (possibly large numbers of) autonomous agents and characters. In this context, SAFIRA is researching ways to make these agents more responsive, familiar, and comfortable to human users. Following Damasio's argument that emotions are necessary as one part of true rationality, these agents may also be more sensible in their actions. They may also be more understandable to humans, who are used to thinking about and interpreting intentional behaviour wrt the emotions underlying it.
Pursuing this vision, this project will bring an affective dimension into the interaction between users and applications, be they 3D VE's or simple Web-based applications. As a main focus we will develop a new model to enrich and augment virtual environments with affective components and characters. Such an enrichment has several phases, that include the following:

1. The use of emotion theories to support the deep modelling of emotion, leading to the richer emotional expressions needed in the synthetic agents or avatars.
2. The use of a component-based approach to the development of a toolkit for affective interactions that will allow scalability and interoperability of affective components over distributed platforms.
3. The use of these theories and toolkit in the development of three demonstrators through which the newly researched functionality can be demonstrated.
4. The development of such demonstrators as not simply testers of emotions in general, but real-time systems, driven by human input and required to have real-time emotional responses.
5. Additionally, we will also aim at the development of new types of multi-sensory interactions through the use of affective wearables, objects and toys, real objects extended with sensory components to sense the behaviour of the user.

In general, this project must be seen as a research (almost FET-like) project in this key action that can lead to exploitation within several other projects within this key action. Indeed, it will bring emotions, personality and in general affect as a new model of interaction, thereby augmenting VE's exploring human interaction with a new perspective. Affective interaction with computers is an extremely critical new area of further research with a large variety of applications in areas such as e-commerce, education, entertainment, Web portals.
Finally, this key action focuses on large-scale integrated systems, and the framework we are developing integrates a wide range of techniques, which can be used together in a modular way in large-scale systems.

5 Innovation

Although affective computing is quickly and strongly carving its own path into end-user applications, it is still in its infancy and making its first steps. Some of the latest research work and achievements in affective computing were presented in recent conferences as the ACM Autonomous Agents 99 where the workshop on "Emotion-based architectures" was one of the most attended. Other initiatives as the British HCI Group meeting on "Affective computing: the role of emotions in HCI", and the 1998 AAAI Fall Symposium "Emotional and Intelligent: The Tangled Knot of Cognition" presented evidence of the impact of affective computing in near future applications.

Recent work in the Agent and Human-Computer Interaction communities shows strong evidence of an interface shift towards the introduction of a mediator between the human and the computer - the interface agent – as the next communication metaphor of near future systems. To reduce the user entry-barriers as well as the information cost structure, current interface agent research aims at the creation of believable anthropomorphised autonomous agents. Endowed with a distinct and predefined personality adequate to the individual cultural and social communication protocols and needs of each end-user, the interface agent will allow such systems to reach much broader audiences in a consistent scalable way. Putting a face on the computer seems to be the current concern of several software houses (be they market leaders, as Microsoft Corporation [Ling,99], or not, as Virtual Personalities Inc. [Maulding,99]) and top European institutes (as DFKI [Wahlster,99] and Imperial College of London [Mamdani,99]). Surveys of the field can be found in [Trappl *et al.*,97]

To achieve believable and personality-rich autonomous agents and bestow upon them the illusion of life, the clear expression of emotions and intentionality has proven to be crucial [Thomas *et al.*,81]. Besides the importance of facial expression in emotional communication (*e.g.* FACS [Ekman,98]), body posture and gesture have also been used with success in conveying the emotional state of synthetic autonomous agents to human participants (*e.g.* Oz at CMU [Bates,94] and Swamped! at MIT [Blumberg,98]). The results of such enriched interactions between autonomous agents inhabiting 2D or 3D worlds and human participants have proved that agents must possess non-verbal as well as verbal communication capabilities. They also suggest that emotions may play an important role in non-verbal communications, since the autonomous agent perceived personality is based on the consistency and regularity of the displayed emotions. Furthermore, wearables [Picard,97] will soon provide applications with the ability of sensing a limited subset of emotions from the human participants. Wearables and sympathetic interfaces [Blumberg,98], besides providing with new research directions for animated character control, may be a key point in closing the interface emotional loop by allowing systems to perceive the emotions of the user.

Underneath the skin of the autonomous agents, psychology and neurology based emotional models implement the agents' coherence in emotional processing. Ortony, Clore and Collings [Ortony *et al.*,88] cognitive theory of emotions is currently one of the most used model for emotion-based architectures (*e.g.* Em system [Reilly,96]), although physiological is also a strong presence in such applications (*e.g.* Gridland [Cañamero,97] and Creatures [Grand *et al.*,97]). However, current research aims at the development of hybrid architectures implementing both the physiological and the subjective experience components associated with emotions.

Thus, there is strong evidence of the need of a toolkit, not tied with any particular theory or model, for the integration of cultural and personality based affective components in the highly personalised services of near future potential applications.

5.1 Emotion Architectures

The major innovation of this project lies in the creation of the affective toolkit, which can be used to enrich applications with an affective dimension. To achieve that, instead of adapting a predefined architecture associated with a pre-specified model of emotions, we will create a consistent framework for the integration of the toolkit components within an underlying architecture trying to overcome the limitations of current personality and emotion based systems, presented in the next sections.

Representation of Development

Since there are many models of agent personality (*e.g.* Neal Reilly [Reilly,96]), but very few that model substantial changes in personality over time, we develop techniques for the representation of changes to personality over time, including changes in the agent's emotional model and ways of processing emotional input.

Emotional Adaptation

As Ortony, Clore and Collins argued in their book [Ortony *et al.*,88], one of the aspects that is important in communication is not so much to build computers that "have" emotions, but rather the have a way to reason about the emotions of others. In this project, we will take a further step, in the sense that we will use adaptive emotional expression to guide the participant in the environment. The affective channel will be used to communicate guidance to the user, learn about his/her sensibility to certain emotions, and exploit this sensibility to provide a better interface communication channel. No current applications use emotional adaptation: the personae are well established and reflect the autonomous agents' individuality when applications must adapt themselves to the user, not the opposite.

Affective Toys

Recent work on affective toys (*e.g.* MIT's Tigger [Kirsch,99]) use audio-visual feedback to the user. However, when the toy is a representation of its cyber-self projection in a virtual environment (*e.g.* Swamped! [Blumberg,98]), the user's attention can not be focused on both the toy and the virtual environment. In this project, we will strive to overcome this "split-senses" problem in such a way that the toy and its avatar become one in the eyes of the user.

Affective User Modeling

User models are currently present in most of end-user applications, enriching the interface to adequate the range of provided services to the user individual needs. However, emotional aspects are not present in these user models when several applications can benefices from this as, for instance, to adequate the timing of the information communication. This project will provide a shell for the integration of affective user modelling in application.

Affective Graphics

In contrast to the frequent artistic goal of communicating a personal perspective on a scene, the traditional goal of computer graphics is to generate maximally photorealistic images of 3D scenes. The result are images which are stupefying in their realism, but also cold and lifeless, lacking the emotional expression and charm of even non-expert human drawing. Even non-photorealistic rendering [Lansdown *et al.*,95] and Burton's [Burton,95] pioneering work in modeling children's drawings are based on an input-output technique, where the goal is to draw a given scene with little or no attention to the emotions and personality which could be expressed through the drawing. In contrast, we will develop techniques of affective graphics, in which drawings express emotion and personality. Such techniques can become the basis for a new generation of lively, personal, less alienating graphics.

Affective Speech

This project will strive to convey emotions and personality via linguistic style. It will study how emotions and personality affect the semantic contents, the syntactic structure and the acoustic realisation of an utterance, the three aspects to which the linguistic style refers, according to Walker and colleagues [Walker *et al.*,]. Drawing upon Cahn's work [Cahn,90], we will compute instructions for a given speech synthesizer so that it conveys certain emotions and personalities.

References:

[Bates,94] Bates J.: The Role of Emotions in Believable Agents. Technical Report CMU-CS-94-136, Carnegie Mellon University, 1994.

[Blumberg,98] Blumberg, B., Swamped! - Using plush toys to direct autonomous animated characters. SIGGRAPH'98 abstracts and applications.

[Blumberg,96] Blumberg, B. Old Tricks, New Dogs: Ethology and Interactive Creatures. PhD Thesis, MIT Media Laboratory, 1996.

[Burton,95] Burton Ed. Thoughtful Drawings: A Computational Model of the Cognitive Nature of Children's Drawing. Computer Graphics Forum, September 1995, C/159-C/170.

[Cahn,90] Cahn J.: The Generation of Affect in Synthesized Speech, Journal of the American Voice I/O Society, vol.8 p1-19,1990.

[Cañamero,97] Cañamero, D.: Modeling Motivation and Emotions as a Basis for Intelligent Behavior, AA'97, ACM Press.

[Ekman,98] Ekman P., What The Face Reveals; Basic And Applied Studies Of Spontaneous Expression Using The Facial Action Coding System (Facs), Oxford University Press, 1998.

[Grand *et al.*,97] Grand, S., Cliff, D., and Malhotra A.: Creatures - Artificial Autonomous Software Agents for Home Entertainment, Proceedings of Autonomous Agents'97, ACM Press.

[Kirsh,99] Dana Kirsch, The Affective Tigger: a study on the construction of an emotionally reactive toy, Master's Thesis, MIT, 1999.

[Lansdown *et al.*,95] Lansdown J. and Schofield S., Expressive Rendering: A Review of Non-Photorealistic Techniques. IEEE Computer Graphics and Applications. May 1995, pp. 29-37.

[Ling,99] Ling, D. (Microsoft), Agents: Brains, Faces and Bodies, Invited presentation at AA'99, ACM Press.

[Mamdani *et al.*,99] Arafa Y, Charlton P, and Mamdani A., Engineering Personal Service Assistants with Lifelike Qualities, EBAA'99 workshop of Autonomous Agents'99.

[Maulding,99] Maulding M. (Virtual Personalities Inc), VERBOTS:Putting a face on natural language, invited presentation at Autonomous Agents'99, ACM Press.

[Ortony *et al.*,88] Ortony A., Clore A., and Collins G., The Cognitive Structure of Emotions, Cambridge University Press, 1988.

[Picard,97] Picard R., Affective Computing, MIT Press, 1997.

[Reilly,96] Reilly, S. Believable Social and Emotional Agents. Ph.D. thesis, Carnegie Mellon University, 1996.

[Thomas *et al.*,81] Thomas J., and Johnston O., Disney Animation: The Illusion of Life, Abbeville Press 1981.

[Trappl *et al.*,97] Trappl R., and Petta, P. (eds.): Craeting Personalities for Synthetic Actors, Springer, Berlin/Heidelberg/New York/Tokyo, LNAI 1195, 1997.

[Wahlster,99] Wahlster W.(DFKI), Personalized Interface Agents for Virtual Webpages, invited presentation at AA'99.

[Walker *et al.*,97] Walker M., Cahn J., Whittaker S.: Improving Linguistic Style: Social and Affective Bases for Agent Personality, Proceedings of Autonomous Agents'97, ACM Press, 1997.

6 Community added value and contribution to EU policies

Europeans are changing dramatically in the way they perceive and use technology. This change in perception does not come simply from witnessing technological advances, nor from being able to obtain all sorts of digital content, but fundamentally from day-to-day contact with and usage of technology. The increase of e-commerce simply reveals that technology is no longer restricted to the workplace, but has also made its arrival into the home routine of Europeans. This integration of technology into daily life is accompanied by the humanisation of human-computer interactions. As illustrated by Reeves and Nass in their book "Media Equation," people perceive technology in a human-like manner and tend to anthropomorphise computers and media. They illustrate with several examples that affect plays a fundamental role in the relations between technology and humans.

This project combines the strength of major players in the area of emotional computing, who are scattered across Europe. The expertise in HCI, Emotion theories, Software agents, Planning, Multi-agent platforms, Standards for Agents, Natural Language, Virtual and Augmented reality and Personal Assistants is gathered together, with the goal of providing Europe with a technology for the future. The toolkit generated in the project will be useful in setting an anchor for affective computing in the EU, by supporting and feeding into the work of next generations of researchers.

6.1 Community Added Value

The project should be carried out at a European Level instead of at national level for several reasons. Most notably, there is a scarcity of researchers with sufficient experience in affective computing in Europe. Working internationally will allow us to reach a critical mass in human, financial, and expertise terms.

In addition, the new technology for building emotional autonomous agents and synthetic characters we will develop in SAFIRA will be useful for a wide range of applications. Working within the IST framework will allow this emerging technology to be used for other IST projects that may need it, such as the proposed SoNG project. More generally, this technology can be used to enhance European software products, making them more profitable and more able to compete with American products, which are simultaneously developing affective computing components.

From a conceptual perspective, the European dimension has a singular advantage over single-nation projects: cross-European projects are inherently multi-cultural. This cross-cultural perspective is invaluable for developing affective applications that can reach across national borders. Without it, researchers are in danger of developing culturally specific products.

7 Contribution to Community Social Objectives

Because of the importance of the emotional and human dimensions of computation, affective computing—the development of computational systems that can understand, process and display emotion-- is becoming a hot topic of research. The EU cannot afford to ignore this development, leaving American researchers to define the way. This is particularly the case because the EU has an advantage which America does not: emotional computing can easily become culturally specific, but the presence of many cultures in the EU means that an international project is less likely to be confined to the emotional 'rules' of a particular culture. In the new generation of interaction agents as they become more sophisticated, it is important that emotions and cultural aspects are taken into account. Specific particularities of each culture, reflected in their emotional profile and in their expressive behaviour, must be present in the interactions provided with technology.
Many current computational systems, including in Artificial Intelligence, are based on the assumption that people are or should be fundamentally rational, and that emotions have little to do with our daily lives. For average users, whose daily experience is not simply one of information processing but also of feeling and reacting to meaningful life situations, such systems can appear incomprehensible, alienating and frightening. In addition, recent research has shown that even human rationality rests upon a basis of emotional knowledge and experience, without which true rationality is not possible [Damasio]. Many researchers are beginning to conclude that a focus on rationality as the center of computing is out-dated and must be replaced by a model that includes emotions as an important part of experience [Picard].
Following this way of thinking, emotions are not simply a distraction but an important asset for humans in understanding the world and one another, an asset that could also be utilised by computational systems. Systems which can understand and reason about emotions will be able to better understand, anticipate, and support real (i.e. not purely rational) human behaviour. Following Damasio, a system which includes such emotional reasoning may also be more truly rational, being able to reason about the social and emotional consequences of its decisions.
Systems which can express emotions will, in turn, be more understandable to human users, who have a substantial capacity to effortlessly interpret emotional expressions and behaviours. These systems can make connections to users in a language which is familiar to them, the language of emotions. Computational systems will be less threatening if they can engage human users in such an emotional and personal way.
In the future, information technology will be ubiquitous, and those who are afraid of or uncomfortable with computational technology will be left behind, both at work and probably in their home lives. Affective computing therefore has the potential of bringing these people back in the fold, making interaction with the information technology of the future open to people who are currently intimidated.

7.1 Compliance to Ethical Requirements

The introduction on Agents with emotions and even personality will have specific ethical problems. To address this issue some of the project deliverables (D3.1, D7.2 and D2.3) will have a section that will explicitly address the potential ethical problems and specific solutions to those problems.
The problem of privacy will also be addressed. With our proposal it will be possible to record information about each user ate a very fine granularity level which can, if not specifically addressed pose some questions about privacy. The some approach already described will be followed in each deliver. An emphasis on privacy security will be addressed.
The project will also have a very restrictive approach towards copyright and storage of personal information. The Project Manager will be the responsible for the implementation of such policy.

References

Damásio, Antonio R. “Descartes’ Error: Emotion, Reason, and the Human Brain.” NY: Avon Books, 1994.

Picard, Rosalind W. “Affective Computing”. Boston: The MIT Press, 1997.

Reeves, Byron and Clifford Nash. “The Media Equation: How People Treat Computers, Television, and New Media Like Real People and Places”. CSLI / Cambridge UP, 1998.

8 Economic development and S&T prospects

We expect the project's results to be usefully disseminated in the following ways:

- Results of the project will be published at international conferences, such as: the Conference on Autonomous Agents, the International Joint Conference on Artificial Intelligence, the European Conference on Artificial Intelligence, the Computer-Human Interaction Conference, the workshop on Embodied Conversational Characters (WECC) and ACM conferences such as SigGRAPH; and in international journals, including the Journal of Applied Artificial Intelligence, the International Journal for Human-Computer Interaction, and the IEEE journals.

- The members of the consortium will participate in standardisation efforts as a way to guarantee the broad adoption of the results obtained in SAFIRA. Thus, the work in SAFIRA on inter-agent communication, real-time interaction, representation and description schemes for emotions will be done in conjunction with standardisation bodies, (FIPA, MPEG-4 and MPEG-7). By developing our work in harmony with these standards and influencing those standards to be able to support affective computing, we will lay the groundwork for new market opportunities for companies using those standards. In particular we will focus on the groups:
    - *Inter-agent communication:* Inter-agent communication is one of the most important FIPA Technical Committees (TC). The SAFIRA project will contribute to the work being developed in this TC. The project will evaluate the possibility of proposing new communicative acts related to communicate emotion. The project will also investigate the extension of FIPA Semantic Language (SL) in order to enrich content expressions with some information or some form of qualification regarding emotion.
    - *Real-time ad-hoc group:* In its first meeting of 1999, FIPA created the ad-hoc group (AHG) on Real-Time. Modest was the only project involved in AHG, so the standardisation work on real-time is now in stand-by
    - Since one of the MPEG-7 goals is to propose standard definitions of object classes widely used in several application domains, the SAFIRA project will contribute for the standardisation work of MPEG-7 by the definition of descriptors for the representation of basic emotions and description schemes for the representation of compound emotions.
    - The compliance with and impact on MPEG4, in restricted situations (in particular in the personal assistant demonstrator), will be done through the direct collaboration with the project SoNG.

- The SAFIRA architectural framework will be applied to other projects in which each research institution is involved (in particular to the SONG project, a project just approved under this same key action). The SoNG project intends to deploy a visual PSA (Personal Assistant) with help/guide roles as the interface agent to produce a portal to Internet applications. SAFIRA may use the SoNG project domain as a testbed for the affect-based agent development toolkit. Such use will allow the development of the affect-behaviour required to create believable interface agent embodiment. The SoNG implementation may provide material for the evaluation of PSA embodiment within a real-time agent environment. SAFIRA may also provide input into the types of facial and body animation and representation libraries (FAPS and BAPS) and for what representations of personality and emotions required in the SoNG project.

- Much of the software developed in SAFIRA will be put into the public domain and made available to researchers for free over the Web. Experience in other projects has shown that this is a substantial help to promote the dissemination of SAFIRA's results and re-use of its framework in subsequent research projects.

- Most of the institutions involved are not purely research institutes (DFKI, INESC, GMD, SICS), but also focus on the dissemination of research results to and their use in industry. They anticipate being able to use SAFIRA's novel technology as part of their normal institutional technology transfer process.

- Installation of a SAFIRA interest group for interested parties from industries and academia. In particular, we will invite industrial organisations currently working with the consortium members to become members of the SAFIRA interest group. For this user group, we will organise specialised workshops where we will inform about new developments in SAFIRA and give tutorials on how to use the software.

Next, we will describe how each individual partner specifically plans to use the project's results. In particular, some partners expect to exploit the results of the project in other projects concerning entertainment, avatars and multi-media.

1. ADETTI expects to use the results of SAFIRA in the ALIVE project and in other Departments of ISCTE. . ADETTI is a partner of the ALIVE project (submitted to the 5th Framework Programme). This project is also concerned with real-time and it aims at contributing to the FIPA real time AHG. The SAFIRA project will also contribute for this standardisation effort.
   Further, the toolkit will also be used to investigate and simulate psychological models of emotion and decision making in the Department of Social Psychology of ISCTE.

2. A large number of DFKI's industrial partners have already announced strong interest in using the technology to be developed in SAFIRA. Currently, DFKI has several long-term cooperations in the area of intuitive multimodal communication with conversational agents and virtual shopping assistants in which the results of SAFIRA will be used. Thus, transfer and dissemination of the results carried out in SAFIRA will be accelerated by DFKI's many contacts to domestic and international research institutions - both in academic and industrial environments - including partnership exchange agreements with several prominent research institutions in Europe, USA, Japan and China. DFKI also hosts technology transfer workshops for its shareholders and other interested groups. Furthermore, the results of SAFIRA will be exploited in a new collaboration with leading commercial companies, such as DaimlerChrysler AG, Philips GmbH, Siemens AG and Sony International (Vol. 34 Mio USD).

3. One of GMD's missions is the transfer of in-house technological advances to other projects in science and industry, and there is a substantial administrative infrastructure available as well as international research and industrial contacts in order to support such transfer. Our philosophy in MARS is to support the development of cutting edge technology by making all software we develop available in the public domain over the World Wide Web, so that other researchers can build on the work we do. We ourselves will connect research results in SAFIRA with ongoing work in avatars and agents in the eRENA project. We also have extensive expertise in and infrastructure for public display of new media works, including in museums and in exhibitions, conferences, and workshops, which we will draw upon to exhibit publically the system developed in WP6.

4. The ICSTM researchers participate in several national and European projects or programmes, in association with a number of different industrial and academic collaborators. As part of a University committed to high quality research, we believe that SAFIRA will further enhance our reputation as leading innovators in the communications field. ICSTM are strongly involved in SAFIRA because we have identified user-agent interfaces, multi-agent systems and multimedia applications as key technologies needed to strengthen and develop our research programme in intelligent communication systems. The results of SAFIRA will directly contribute to an

increase in our user-interface and agent-system design skills and knowledge, which can be used in agent-based engineering of client-centred services for the communication systems of the future. This will therefore be exploited through application and further development of theories, tools, technologies, base-line platforms, and methodologies developed by ICSTM as part of SAFIRA in other projects.

5. The INESC's researchers participate in several national and European projects that can take advantage of the results achieved in SAFIRA. In particular, INESC intends to use parts of the core of the affective components in a learning context project (the DiviLab project, which main aim is to develop virtual laboratories for distance learning). The role of emphatic characters (conveying emotional attitudes in the interaction with learners) as a way to make learning more motivating can be explored with the results of SAFIRA.

9 Workplan

9.1 General description

To attain the objectives enumerated, the work plan contains two types of workpackages: vertical and horizontal ones. The vertical workpackages focus on research issues and alternative approaches to deal with the main scientific problems of creating affective autonomous agents. The horizontal ones deal with general integration, concept demonstrators and evaluation issues.
In the vertical workpackages we have to research and develop along the three fundamental phases in affective computing: the Affective Sensory for Autonomous Agents (WP 3), Affective Reasoning, Planning and Learning (WP4) and Affective Communication and Expression (WP 5). These three parts form the core research and also components that must be integrated (WP2) into any emotion-based architecture.
Concerning the horizontal workpackages, it is in WP2 that the common *shell* interface is developed to facilitate the integration of affective components, so that we can achieve affective autonomous agent architectures. In WP6 three demonstrators will be developed. Such demonstrators are simple examples of how to use affective components and how to embed the components of the toolkit in order to convey emotional believability. Finally, in WP7 user evaluation will be carried out. Figure 1 illustrates such a structure for the work plan.

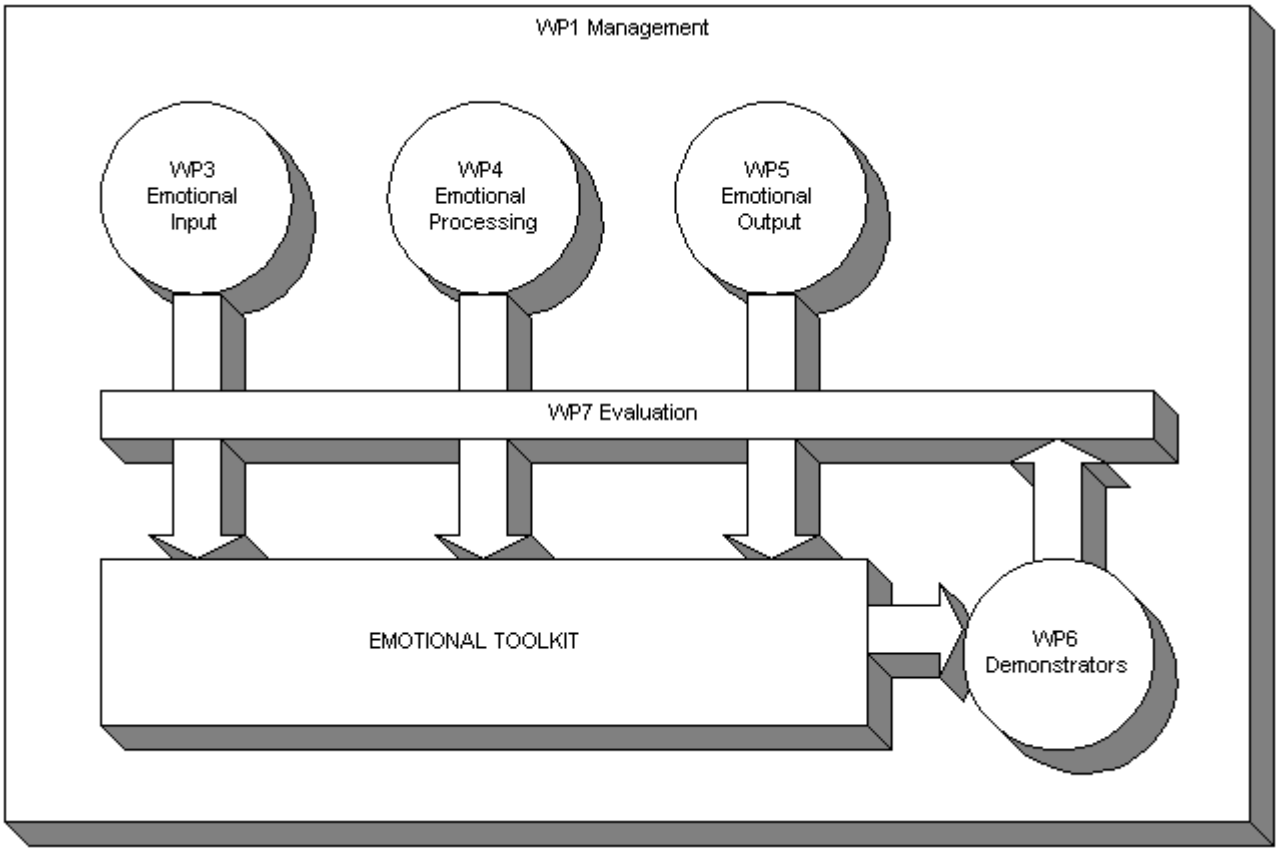

Figure 1- Workpackages structure and interaction

In the remaining of this section we will describe the tasks to be developed within all these workpackages.

9.2 Management and Dissemination (WP1)

General coordination:: **Partner 1**
Participants: 2,3,4,5,6,7

This workpackage serves to co-ordinate the partners activities, organise meetings and workshops, disseminate the results obtained, participate in exhibitions and in standard's meetings. All partners are involved in this workpackage. This workpackage will also serve to disseminate the results of the project and to establish a link with other projects in KAIV, in particular the projects SONG, INTERFACE and ALIVE. It will also be in this workpackage that the consortium will assist the Commission in establishing the link between the KAIV/E3 and the I3/FET communities.
A more detailed description of the way the management and dissemination will be conducted in SAFIRA can be found in Section 9.7 of this document. Description of Milestones and Deliverables of this workpackage can be found in form B3.

9.3 Toolkit, Architectures and Integration of Affective Computing in Synthetic Characters (WP2)

General coordination: Partner 5
Participants: 1,2,3,4,6,7
Total of MM: 26,6

This workpackage serves as a focal point for co-ordinating and integrating the defined cognitive and affective components that are required to achieve affective computing in real-time multi-agent applications. The research objective is to provide both a context and domain-free *Shell* that delineates an interface structure between the various *independent* architectural components. The *Shell* will facilitate the formation (formalisation) of a common generalised notion of reactive or emergent affective behaviour that avoids tightly-coupled domain-specific agent behaviour and functionality. It will also promote a foundation for the conceptual and functional design of character-based quasi-human representation behaviour and embodiments. The *Shell,* hence, captures the basic conceptualisation about agent perception, behavioural and embodied responses, behavioural reasoning, affective planning, learning and maintaining memory in some internal structure. Consequently, various agent models in different contexts become an instantiation of the *Shell,* allowing a variation in the conceptualisation of perception, behavioural state, and embodiment on the whole. This approach will facilitate for the formalisation of communication and interaction channels between the components and agents whilst preserving the autonomy and particular strengths of the partners (components) involved.
This workpackage facilitates the integration of components implemented in WP3, WP4 and WP5, through the specification of common APIs and the inter-agent communication. Producing a toolkit for enabling affect-based agent behaviour in real-time multi-agent systems. It is also in this workpackage that a framework for enriching interactions and applications with an affective dimension will be designed. This framework will provide some guidelines for enriching applications with affective interaction and methodologies for developing affective real-time multi-agent systems. Which will be subsequently used for the demonstrators developed in WP6.

Technical Approach

- Based on a state-of-the-art analysis, the spectrum of current technological alternatives of agent architectures will be identified. This will then be extended to identify the components required for real-time multi-agent systems.

- The concept of autonomous agents that can exhibit affective behaviour and control will be analysed, resulting in a set of requirements on open architectures supporting such agents.
- A model of agent, agent societies, and agent architectures will be defined, leading to a design of the affective agent framework that will be used in the ensuing technological development throughout the project.
- The design will be implemented as a toolkit, supporting execution of agents on heterogeneous platforms, providing the necessary functionality to enable agents to work in both a distributed and disconnected mode.
- The framework so developed will be the foundation for a series of concept demonstrators to be developed in WP6. Such concept demonstrators will illustrate different approaches and solutions to modelling, structuring, packaging and visualising agents.

Task 2.1 Survey and analyse of affective components for different architectures

Coordination: **Partner 5**
Participants: 1,2,4,6
Total MM: 5,6

Survey and analyse the different architectures and mechanisms by which emotions and affect play a role in the behaviour of autonomous agents. State-of-the-art survey of research concerning individual components will be analysed in tasks T3.1, T3.2, T4.1 and WP5 and used here to define a set of components that are necessary to achieve affective modes of interaction.

Task 2.2 Conceptual design and integration of affective components

Coordination: Partner 5
Participants: 1,2,3,4,6,7
Total MM: 13,5

Task T2.2 will provide the conceptual design of a modular framework for enabling the construction of autonomous agents with affective behaviour and control. This task will result in the definition of coherent integration and interoperation of a defined set of modules (to support sensory input, emotions synthesis, planning, and expression) through the specification of common APIs, ontologies and inter-agent communication support to facilitate the information flow of affect states between agents.
Design implementations will be integrated through the assembling of a toolkit for affective computing by using a *shell*, the appropriate API's and support for inter-agent communication. This toolkit will embed the research problems addressed in WP3, 4 and 5. To validate the framework and toolkit a set of agent demonstrators will be built to demonstrate different concepts concerning structuring, packaging and visualising agents. Enabling the vision of the project beyond the scope of just the implemented demonstrators and current technologies.

Task 2.3 Conceptual framework for building and extending applications with affective computing.

Coordination: Partner 5
Participants:1,2,3,4,6,7
Total MM: 7,5
In this task we will define a framework for the construction of characters that interact in an emotional way. We will make the link between personality and emotions. The task incorporate the results and achievements of task T2.2 to define and formalise a methodology for the end-to-end engineering of affective autonomous multi-agent systems. This framework will be evaluated in WP 7 using the demonstrators developed in WP6.

9.4 The Affective Sensory for Autonomous Agents (WP3)

General coordination:: **Partner 1**
Participants: 2, 4, 5
Total MM: 15

Sensors are one important part of an affective application since they can provide information about the user's behaviour or physical state. Indeed, since people are already physically in contact with the computer through the keyboard or other input devices, augmenting their contact with sensors that can capture physiological characteristics of the user or with sensors put in special objects (such as toys) will provide us with new forms of affective communication. In this work package a set of problems dealing with perception and emotion will be handled and, as a result, tools for performing affective sensing will be provided. The sensory components developed in this WP will be deployed into the overall toolkit (see WP2). In particular, we will concentrate in the following type of physical input: keyboards and affective sensors in objects. Such types of input will be analysed through a set of input filters (analysis modules) that will give meaning to the data captured. The results of the analysis will be stored in a form of user models. These user models will then be used by the applications to adapt the interaction to the particular characteristics of that user. Further, the user models can be used to help the analysis of the captured data.

Technical Approach
The technical and scientific goals of this project are as follows:
1. Specify and construct a component that will analyse user's behaviour with affective objects aiming its integration in the toolkit (this goal will feed into WP2).
2. Extend current user modelling techniques to represent affect and personality of the user. Specify and develop a shell for affective user modelling.
3. Evaluate the components developed.

Task 3.1. Affective input through objects
Coordination: **Partner 1**
Participants: 4
Total MM: 7

Grounding the interaction with the users in objects from the real world as well as with affective wearables is one of the goals of this task. The aim is to specify and construct a real-world-based interface that will allow the user to influence an agent's emotions through touch and/or handling. In particular, the development of toys (or for example books) that have sensors used to identify affective behaviours and behaviour patterns of the user. For example the toy being carried by the child, being snapped, or simply being touched on sensitive parts. Sensors that detect the position of the toy, the way it is handled by the child, will be incorporated into two or three different types of toys. The other type of affective input used is a magical mailbox, where users can influence agents through the expressions pictured in postcards printed to be used by the mailbox. This input type augments the interface between users and computers with the physical world. As a result, a set of acquisition and interpretation modules will be developed to acquire information about the user based on the sensors integrated within the toys.

Task 3.2. User Models and Emotions
Coordination:: **Partner 1**
Participants: 2,5
Total MM: 8

User modelling aims at capturing information about the user and infer usually his/her preferences, goals, plans, and knowledge. However, from the observation of users' actions and behaviour and given the strong link between affect and cognition, it is now more and more important for any

software application to model and reason about the user's affective state. The data captured through the keyboard, affective wearables or affective objects can be used for the construction of what we will call "affective user models" [Elliot]. The identification of affective states in the user will rely on the emotion theories studied in Task 4.1, in particular in appraisal theories such as the OCC theory [Orthony *et al.*,88]. Such theories will provide the means to infer affective states of the user based in his/her behaviour. Finally, since the interaction of autonomous agents is not only with user but also with other agents, we will adapt the affective user modelling approach to be used in acquiring, storing and reasoning about other affective autonomous agents (this task will take input from Tasks 4.1, 4.2 and 4.3).

9.5 Reasoning, Planning and Learning with Emotions (WP4)

General coordination: **Partner 2**
Participants*:* 1, 3, 4, 5, 6, 7
Total MM: 28

This Workpackage will deal with the problem of embedding emotion and cognition in a machine (being it a synthetic character, an agent or even a robot). The overall goal is to develop technologies that can be put together to build a machine that can exhibit both emotionally controlled behaviour and emotionally expressive behaviour grounded on its internal architecture. This work package focuses on the internal mechanisms and structures that can be used in a synthetic character to support affective phenomena and the relation between emotion and cognition. This includes the definition and implementation of appraisal capabilities (i.e., the process by which an agent evaluates each situation with respect to its values, motives and attitudes and generates its emotions), the definition and implementation of emotion controlled decision making, planning and other action selection processes, and the definition and implementation of mechanisms responsible for emotion evolution and development.
It will also be in this work package that a tool will be designed for designers to define their own set of domain-specific emotions and build synthetic characters with the defined set of emotions.

Technical Approach
We will approach the main problem of this work package by satisfying the following objectives:
1. Producing survey of theories of emotion to be used in the synthesis of emotions for autonomous agents;
2. Creating a model of the development and evolution of emotions
3. Building a computational tool to define and implement the appraisal components of synthetic characters; and
4. Building a computational tool to be used to define and implement emotion-dependent decision making, planning and action selection mechanisms.

The results achieved in the first objective will condition all other objectives, and the concrete realisation of objectives 4 and 5 depend on the results of objectives 1, 2 and 3.
In order to achieve the defined objectives, this workpackage is organised in five tasks: (1*) synthetic emotions*, (2) *appraisal mechanisms*, (3) *emotion-controlled decision making, planning and action selection*, and (4) *evolution and development of emotions*. Tasks 2, 3, and 4 will produce computational tools to support the development of synthetic characters with emotions. These tools will be integrated in WP2.
It is important to stress that the emotion models of other agents/users (see WP3, Task 3.4), as well as other kinds of inputs, may be used both by the appraisal mechanism, the planning component, the decision making and action selection processes, and also in the emotional evolution of the agent. And, the behaviour of the agent (which is expressed in ways defined in WP5) may directly result from the appraisal process or from the decision making, planning and action selection processes.

Task 4.1. Synthetic emotions
Coordination: Partner 6
Participants: 1,2,3,4,7
Total MM: 7

This task addresses the problem of how to give the capability of the computers (say synthetic characters) to represent reason, plan and learn having emotions. It also addresses the problem of how to model emotions of other characters and the user, in order to adapt to his/her emotional state. There are many theories about emotions that can serve as the base for the creation of synthetic emotions, such as: the work by OCC [Ortony *et al.*,88], Roseman's cognitive appraisal model [Roseman *et al.*,96]). In this task several of these theories will be analysed and the theories chosen will be used for the subsequent tasks in this workpackage.

Task 4.2. Appraisal mechanisms
Coordination: Partner 2
Participants: 4,5,6
Total MM: 9

Conceptually, the generation of emotions in synthetic characters depends on their evaluation of each situation with respect to their instincts, motives, attitudes and values. This evaluation process takes inputs pertaining to several kinds of entities, such as the physical environment of the agent, other agents of an interaction (e.g., the users), available resources, internal memories, etc. This evaluation is called the appraisal process. The exact contents and mechanisms of the appraisal process depend on the specific models and theories chosen and/or designed in Task 4.1. In this task the representation and processing of appraisal structures as well as the acquisition and adaptation of appraisal structures will be handled. This task links with task 4.3 so that the appraisal mechanism and the synthetic emotions (Task 4.1) are used for decision making and planning.

Task 4.3. Decision making, Planning and Emotions
Coordination: **Partner 2**
Participants:1,3,6
Total MM: 8

Planning methods provide powerful techniques for obtaining the behaviour of synthetic characters. Goals and Plans have a dual role in an emotion-based architecture. In one hand the planning must rely on the emotions of the characters to handle conflicting goals, limited resources, or imperfect information [Frijda *et al*.,87], [Oatley *et al.*,87], and on the other hand they can serve as the basis for the cognitive appraisal. In this task we will extend an existing planner taking into account this dual role of plans in affective behaviour, thus, the affective planner that will use the synthetic emotions defined (Task 4.1) and provides information about the plans and goals to be used in the appraisal mechanism.

Task 4.4. Evolution and Development of Emotions
Coordination: **Partner 4**
Participants: 1
Total MM: 4

For some agents, overall emotional models (which can be a large part of the agent's personality) are not static over time. For example, agents may develop and change their personality in response to significant life events. This subtask will develop a preliminary, usable model of emotional development.
Development is represented as a directed graph of personality stages, each of which may have associated with it changes to the agent's emotional model and way of processing emotional input

(such as the emotional analysis done in Task 3.2). Each stage may also bring with it specific behavioural changes. The stages represent a specific life phase. Each stage has associated with it entrance conditions that define when that stage has been reached. The developmental graph defines a partial order; an agent may be in multiple stages at once (for example, when the stages are about different parts of its personality). Because development is not well understood, this is intended as a preliminary but useful foray into development in order to provide immediate support for applications such as Task 6.1 and Task 6.2.

9.6 Expression- Communicating and Expressing Emotions (WP5)

General coordination: **Partner 4**
Participants: 1, 3, 5
Total MM: 34

If autonomous agents are to be convincingly emotional in their interactions, it is not enough for them to be able to understand and reason about emotions, and to generate behavioural changes based on those emotions. Their emotions must also be expressed understandably in the agent's perceptible behaviour. In this workpackage, we develop support for the believable and comprehensible expression of the emotions generated in WP4. Each task focuses on a different modality of communication needed for the demonstrators in WP 6: through facial expression, in bodily action, through graphics, and by using natural language.

Technical Approach
We will approach the main problem of this work package by satisfying the following objectives:

1. Development of APIs and plug-ins to allow agents who are dynamically changing their behaviour and emotional state to communicate their emotions through existing facial animation packages.
2. Development of tools to support the expression of emotions and personality through body movement, including a tool to automatically learn expressive behaviours based on user feedback.
3. Development of tools to generate drawings in real-time which reflect an agent's emotions and personality.
4. Development of tools and techniques to use linguistic style to express emotion and personality.

The tasks needed to attain these objectives are:

Task 5.1. Facial Expressions
Coordination: **Partner 5**
Participants:1
Total MM: 3,5

This task will concentrate on the generation of dynamic facial expressions. Extensive research regarding facial expressions has produced many sophisticated algorithms that are capable of producing reasonably effective representations of emotional states and personality traits. However, such work generally does not focus on modelling in a dynamic real-time environment, where behaviour is not static but changing based on both the agent's goals and incoming data. This task will concentrate on linking facial expression generation with the processes responsible for producing the facial expressive dynamically. The objective of the task is to produce a generic interface between existing facial animation technology like FaceWorks or Extempo by providing extensive APIs and plug-ins (WP 4).
The task will produce facial animations based on Ekman's Facial Action Coding System (FACS) [Ekman,78] where the facial expressive motions are derived from unique combinations of facial muscle groups are identified and classified into action units that can be combined to formulate most all facial expressions. To provide a varying degree of expression intensities, these action units are

contracted and retracted according to the behaviour to be represented. The expressive behaviour that are manifested through a full face complements the research on full body representations in Task 5.2. Providing the enabling support and research for both types of manifestations opens the door for investigation and evaluation of both types of expression in different demonstrators. This task will give input to Tasks 6.2 and 6.3.

Task 5.2. Body Expression
Coordination: **Partner 1**
Total MM: 7

Classical animators are masters at conveying intentionality and emotions through the physical movements of their characters. In The Illusion of Life, Ollie and Johnston [Thomas *et al*.,81] argue that simple changes in bodily movement can convey radically different emotions to human observers. Similarly, graphically represented autonomous agents could express a great deal of emotion and personality based on the way in which they move their bodies -- if it were not for the fact that these highly expressive bodily movements are surprisingly difficult to design and to control in a way that is dynamically responsive to user activity.
The goal of this task is to develop tools that provide support for the development of such movements for autonomous agents, as needed in Tasks 6.2 and 6.3. These tools will become part of the architecture in WP2. One of those tools will be a system to allow agents to automatically learn believable, expressive behaviour. The system will generate alternative behaviours, using feedback from the user as an evaluation function for deciding when that behaviour is truly expressive. It will also be used to automatically generate behaviours that integrate behaviours based on different emotional levels; for example, a happy walking behaviour could be integrated with a sad walking behaviour to generate a behaviour that varies meaningfully for all emotions between happy and sad. Additional tools will be generated as necessary for the demonstrators.

Task 5.3. Affective Rendering
Coordination: **Partner 4**
Total MM: 12

Much computer graphics focuses on the generation of photorealistic imagery, which is often breathtaking in its accuracy but simultaneously cold and lifeless. The goal of this task is to provide a tool that can generate graphics interactively, in real time, which are expressive of emotion, personality, and even developmental stage (using the developmental model developed in Task 4.5). The graphics are cartoons drawn in a way reminiscent of children's drawings, which are generally expressive and charming in a way computer graphics, for all their complexity and power, are not. Because of the real-time situation of the system, the cartoons generated must be expressive both in terms of content and pacing; for example, the agent draws faster when energetic and slower when tired. The graphics are driven by the emotion and development of the agent based on the extensive literature on the psychology of children's drawings (e.g. Richter [Richter,88]).

Task 5.4. Natural Language and Speech Generation with Affect
Coordination: **Partner 3**
Total MM: 9

The main objective of this task is to convey emotion and personality via linguistic style. According to Walker and colleagues, linguistic style refers to 3 things: the semantic contents, the syntactic structure and the acoustic realisation of an utterance. In this task, we will examine how linguistic style may be conveyed via emotion and personality. For text generation, we will rely on a presentation planning component and a template-based generator we have already developed.

a) Semantic contents- Starting from a complex presentation goal, the content planner performs a decomposition into elementary presentation acts, such as pointing and speaking. We will examine how this decomposition process can be constrained by a character's emotions and personality.
b) Syntactic structure- Based on a corpus, we will identify syntactic features of spoken language, such as complexity and specificity, and examine the interrelationship between such features and a character's emotions and personality.
b) Acoustic realisation- We will not develop our own speech synthesizer, but rely on commercially or freely available software. Drawing upon Cahn's [Cahn,89] work, we will compute instructions for a given speech synthesizer so that it conveys certain emotions and personalities.

Task 5.5. Affective inter-agent communication
Coordination: Partner 5
Participants 1
Total MM: 2,5

The expression of emotion is not only to convey to the users but it can also be necessary to communicate it to other software agents in a multi-agent system. For the implemented components to be fully converged and effective in a real-time multi-agent system the agents must have some knowledge about the surrounding environment which would include affective knowledge about internal and external states. The agents must have a semantic and contextual understanding of the information being exchanged. For this purpose this task will use the notion of meta-level knowledge representation of affective relations which are annotations of objects being manipulated between the agents in a Multi-agent system. This task will have a major impact in standards for agent technologies (such as FIPA) in particular for the agent communication languages (ACLs).

9.7 Demonstrators (WP6)

General coordination: **1**
Participants: 4, 5
Total MM: 21

The WP6 deals with the design, development applications that utilise affective reasoning and emotion-based interaction. The work package has a dual goal: (1) to prove experimentally the validity of the conducted research. (2) to illustrate the use of the framework and toolkit in innovative and practical examples, where emotion and personality based autonomous agents play a fundamental role.
For each one of the demonstrator, there will be an initial study of the theories and types of emotions that may occur in these scenarios as well as the components used for the agent's architectures. We will develop three demonstrators: The Influencing Machine, an augmented realities 3D Fantasy world, and a personal assistant.
In the demonstrators we will try to cover and analyse the impact of affective interactions in a wide range of target users, covering adults and children. We will study the impact of affective interactions with adults, having no particular needs or characteristics (thus selected in a way that will cover a wide range of ages and backgrounds), through the personal assistant and Influencing Machine demonstrators. We will also target children ages between 7 and 12 through the fantasy world and the Influencing Machine (these users will be selected through the collaboration that the partners have with schools- in particular with the school "O Nosso Sonho" in Portugal).

Technical Approach
The work package consists of three tasks that focus on the design and development of the demonstrators. The first task will be only an integration task to test the components developed within the other workpackages, and cannot be seen as a demonstrator as such.

Task 6.1. The Influencing Machine
Coordination:: **Partner 4**
Total MM: 1MM

The objectives of this integration task are:
1. To show the generation of affective graphics in a convincing manner
2. To illustrate and explore the development of emotions (developed in workpackage 4).

The influencing machine will take advantage of the technique of affective rendering developed within WP5. In this application, the user enters a large room, onto the walls of which a computational agent (who is invisible) is drawing. The agent starts off at the age of 9 months. The user can use the magic mailbox (developed in Task 3.1) to influence the emotions of the agent, which in turn affect its personality and developmental stage (the agent gradually ages over the course of the interaction). These changes can be seen in the ensuing graphics, which are designed according to the (extensive) literature in children's drawings and their emotional meaning. There are several components to this task that come from the toolkit, in particular those coming from Tasks 3.1, 4.1, 4.2, 4.4, and 5.3).
This task will be a mere integration task where some of these components will be brought together.

Task 6.2. Toys in Affective 3D Fantasy World (FantasyA)
Coordination: Partner 1
Total MM: 10 MM

This application will explore the interaction between a human participant who, at the same time, interacts with physical toys (developed in Task 3.1), and projects herself into a synthetic 3D world, virtualizing a fantasy world where the toy is also embodied. The ideas behind this demonstrator take into account:
1. The real world- that is the world where the child interacts with the affective toy;
2. The virtual world, which is a computer world that contains avatars of the child and of the affective toy; and
3. the fantasy world of the user.

These three worlds are connected at two centerpoints: the user and the toys. The affective toy (SenToy) (developed in Task 3.2) will be extended to communicate with the 3D Fantasy World application (FantasyA).

The 3D Virtual World will have the following features:
1. It allows the child/user and the characters to act and interact, emerging affective narratives between the characters.
2. The emergence of the narratives will be a result of the behaviours of the user (and thus the controlled avatar) and her/his interactions with the toy and the characters in the virtual world.
3. The characters in the 3D virtual world can play special roles in a game-like manner.

In the 3D world the virtual toys (avatars) have models of the user/avatar (using the user modelling component developed in Task 3.2).

4. Each character will react to the user not only by behaviour in the 3D virtual world by also by displaying other emotionally charged cues (use of the affective body expression developed in WP5).

We will explore how interaction with synthetic characters affect the user, e.g. if they "convince" the user to perform certain tasks to help them in achieving their goals. One interesting problem is to deal with in this type of augmented reality scenario is the "*split-senses*" problem, that is, the user (child) may be seeing and listening to virtual events on the screen and in parallel interacting with the toy physically, touching it, hugging it, etc.

This application comprises many of the developments from other work packages since it is imperative that

- the virtual embodiments of characters can convey emotions in a lucid manner, and these can be perceived by other characters (use of results from WP5);
- they can perceive and react to the emotions of other characters and the user (WP3);
- characters can adapt to unexpected events (the human participant activities) and menace their goals as individuals (WP4).

Task 6.3. An Affective Personal Service Assistant (James the Butler)
Coordination: Partner 5
Total MM: 10MM

Personal Service Assistants (PSAs) are software agents that employ intelligence and adaptive reasoning methods to provide active, collaborative assistance to a user of a particular application. Their role is to act as mediators between the user and the various services provided by the application.
The objective of this demonstrator is thus, to provide an autonomous PSA agent with the skills necessary to exhibit lifelike qualities manifested in textual, verbal and visual behaviour and action. The PSA may also take on different functional roles like a Sales agent, Help agent and much more. The PSA can acquire the emotional state of the user (developed in Task 3.1). In this demonstrator the PSA will be a butler that will sell wines in a wine shop.

In general, this demonstrator aims at constructing a personal assistant with the following features:

1. it personalises the interface, by monitoring and sensing each individuals capabilities, interests and preferences.
2. models the user also by predicting his/her emotional state (using the affective user modelling component developed in workpackage 3)
3. it establishes the communication with a user through affective conversational interactions.

This demonstrator is a convergence of the various affective components defined in WP3, WP4, and WP5. They will be integrated through a common shell (WP2).
To be able to provide capable and collaborative help, James must have a semantic and contextual understanding of the information being exchanged. This requires a theoretical framework for representing knowledge and belief of agents interacting with other agents. This includes frameworks for representing uncertain knowledge about the surrounding environment evolving with experience and time, awareness of the implication of time constraints, and context-based behaviour. For this purpose we will use the notion of meta-level knowledge representation which are annotations of objects being manipulated between the visual framework (PSA) and the backend system (service agents and architectural components). This provides an understanding of the content being handled and hence a better awareness of the environment. This also includes affective

states of the user and of other agents so that affective inter-agent communication can be established (see task 5.5)

9.8 Evaluation (WP7)

General coordination: **Partner 7**
Participants: 1,2,4,5,6
Total MM: 23

The evaluations carried out within this project have a double purpose. The first is to investigate the impact of affective reasoning techniques on user interfaces, and the other is to develop an understanding of the impact of emotion-based interaction in interfaces, independently of how this interaction is realised. Thus, WP7 deals with the evaluation of the SAFIRA approach in two ways: first, by evaluating the framework and toolkit through the analysis of the process of embedding the affective components in applications; and second by evaluating the impact that such affective components have on the developed demonstrators which utilise affective reasoning and emotion-based interactions. Finally, as the field of emotion-based interaction is quite new, much of the evaluation will be qualitative in nature, focussing on capturing user impressions of and demands on emotional interfaces.

Task 7.1. Framework and Toolkit Evaluation
Coordination: **Partner 7**
Participants: 1,4,5,6
Total MM: 10

The development of the demonstrators will be based on the components (developed in WP3, WP4 and WP5) provided by the affective toolkit (WP2). In this task, a set of tests will be developed to assess the use of the framework and toolkit by the developers of the demonstrators. This evaluation will be qualitative in nature.

Task 7.2. Demonstrators Evaluation
Coordination: Partner 7
Participants: 1,4,5,6
Total MM: 13

The applications have been chosen to enable a wide range of evaluations with different types of users that cover several objectives. From the user evaluation perspective, the Influencing Machine is seen as a concept demonstrator application. The user evaluation of this demonstrator will mainly be qualitative, focussing on user reactions to this type of affective applications.
Differently, the toy world application is one where affective synthetic characters interact both with each other, and with users which will allow the test of the effects of emotional reasoning and emotional interaction in user-system interaction (thus, obtain some results on the use of the components developed in WP4).
Finally, the PSA demonstrator will bring a different perspective allowing the evaluation of more objective effects of emotional interaction. In this scenario, the aim is to provide flexible support for users interacting with multiple services in a personalised way. Here, we will compare different types of qualitative effects of introducing an affective PSA, in comparison both to traditional direct manipulation interfaces, and to non-affective versions of the PSA.

9.9 Tables of Distribution of Man Months work between the partners

9.9.1 Workpackage 2

	WP2	**Res:ICSTM**		
	T2.1	T2.2	T2.3	total
INESC	0,5	2	0,5	3
ADETTI	1,6	2,5	1,5	5,6
DFKI		1	1	2
GMD	0,5	1	0,5	2
ICSTM	2	5	2	9
OFAI	1	1	1	3
SICS		1	1	2
Total	5	13,5	7,5	26,6

Table 1. *Table of MM estimated to contribute to the Tasks of WP2*

9.9.2 Workpackage 3

	WP3	**Res:INESC**	
	T3.1	T3.2	total
INESC	3	3	6
ADETTI	1	2	3
DFKI			0
GMD	3		3
ICSTM		3	3
OFAI			0
SICS			0
Total	7	8	15

Table 2. *Table of MM estimated to contribute to the Tasks of WP3*

9.9.3 Workpackage 4

	WP4	**Res:ADETTI**			
	T4.1	T4.2	T4.3	T4.4	total
INESC	1		2	1	4
ADETTI	1	5	4		10
DFKI	1		1		2
GMD	0,5	0,5		3	4
ICSTM	1	1			2
OFAI	1,5	2,5	1		5
SICS	1				1
Total	7	9	8	4	28

Table 3. *Table of MM estimated to contribute to the Tasks of WP4*

9.9.4 Workpackage 5

	WP5	Res:ICSTM				
	T5.1	T5.2	T5.3	T5.4	T5.5	total
INESC	0,5	7			0,5	8
ADETTI						0
DFKI				9		9
GMD			12			12
ICSTM	3				2	5
OFAI						0
SICS						0
Total	3,5	7	12	9	2,5	34

Table 4. *Table of MM estimated to contribute to the Tasks of WP5*

9.9.5 Workpackage 6

	WP6	Res:INESC		
	T6.1	T6.2	T6.3	total
INESC		10		9
ADETTI				0
DFKI				0
GMD	1			1
ICSTM			10	10
OFAI				0
SICS				0
Total	1	10	10	21

Table 5. *Table of MM estimated to contribute to the Tasks of WP6*

9.9.6 Workpackage 7

	WP7	Res:SICS	
	T7.1	T7.2	total
INESC	2	2	4
ADETTI	0	1	1
DFKI			0
GMD	1	1	2
ICSTM	0,5	0,5	1
OFAI	2	3	5
SICS	4,5	5,5	10
Total	10	13	23

Table 6. *Table of MM estimated to contribute to the Tasks of WP7*

References

[Cahn,89] Cahn, J. E. Generating Expression in Synthesized Speech. Master's Thesis, Massachusetts Institute of Technology, 1989.

[Ekman,78] Ekman, P. and W. Fresen The Facial Action Coding System Palo Alto: Consulting Psychologist Press, 1978.

[Elliott] Elliott, C. The affective Reasoner: A Process Model of Emotions in a Multi-Agent System, PhD Thesis, Northwestern University.

[Frijda *et al.*,87] Frijda N. & Swagerman, J. "Can computers feel? Theory and design of an emotional system". *Cognition and Emotion*, 1, 235-257, 1987.

[Oatley *et al.*,87], Oatley, K. & Johnson-Laird, P. "Towards a Cognitive Theory of Emotions", in Cognition and Emotion, 1(1) pp 29-50, 1987.

[Ortony *et al.*,88] Ortony A., Clore A., and Collins G., The Cognitive Structure of Emotions, Cambridge University Press, 1988.

[Richter,88] Richter, H-G. Die Kinderzeichnung: Entwicklung, Interpretation, Ästhetik. Stuttgart: Verlag Freies Geistesleben, 1988.

[Roseman *et al*.,96] Roseman, I. "Appraisal determinants of discrete emotions" Cognition and Emotion, 5(3):161-200, 1991.

[Thomas et al.,81] Thomas, F. and O. Johnston. The Illusion of Life: Disney Animation. Rev. Ed. NY: Hyperion, 1981.

9.10 Workpackage list

Work-package No	Workpackage title	Lead contractor No	Person-months	Start month	End month	Phase	Deliv-erable No
WP1	Management.	1	25	0	26		6,16,18
WP2	Architectures, Toolkit and Integration.	5	26,6	0	26		2,5,17
WP3	Affective Acquisition.	1	15	3	20		7,8
WP4	Reasoning, Planning and Learning with Emotions.	6	28	0	20		1,11,12
WP5	Communicating and Expressing Emotions.	4 (changed to 5)	34	3	22		3,13
WP6	Demonstrators.	1	21	12	25		9,14
WP7	Evaluation.	7	23	6	26		4,10,15
	TOTAL		172,6				

9.11 Workpackages description

B3.	**Workpackage description**						
Workpackage number :	1						
Start date or starting event:	Month 0						
Participant number:	**1**	2	3	4	5	6	7
Person-months per participant:	**17,4**	1,6	1	1	2	1	1

Objectives

- To coordinate partners' activities
- To define and monitor project policies and resolve contractual matters (between partners and with the Commission)
- To organise meetings and workshops
- To disseminate results and follow the exploitation plan
- To present the prototypes
- To participate in exhibitions
- To establish the link with other projects in the KAIV
- To assist the Comission in establishing the link between KAIV and I3/FET projects.
- To assure the quality of the work which includes:
  - Assessment of evaluation procedure and project progress
  - Quality assurance will be regular issue in the project meetings
  - Open source dissemination of the results for the Community via a web-site

Description of work

The management workpackage will last for the whole duration of the project. The management will be done by the management team, the Project Management Board (PMB), which is made up of representatives from all partners plus the Project Manager (representative of partner 1). The role of the PMB is to decide on operational and management issues of the project following the objectives stated.

Deliverables

D1.1 (M12) Quality Assurance Report.
D1.2 (M26) Quality Assurance Report.
D1.3 (M26) Web site for Toolkit Dissemination

Milestones and expected result

M0 M4 M8 M12 M16 M20 M23, Project Management Meetings (7)
M18 Public demonstration of the project (toolkit and prototypes of demonstrators)
M26 Final prototype and demonstrators

B3.	Workpackage description						
Workpackage number :	2						
Start date or starting event:	Month 0						
Participant number:	1	2	3	4	**5**	6	7
Person-months per participant:	4	5	2	2	**8,6**	3	2

Objectives

- To identify requirements on systems for affective autonomous agents
- To specify architectural models for affective autonomous agents
- To design a framework for affective autonomous agents development
- To implement the framework.
- To develop a toolkit and necessary APIs for affective autonomous multi-agent systems development
- To define and formalise an end-to-end engineering methodology for the design and development
- To validate the methodology and framework by building agent demonstrators, demonstrating different concepts concerning structuring, packaging and visualising agents. Enabling the vision of the project beyond the scope of just the implemented demonstrators and current technologies.
- To disseminate information about achieved knowledge to standard bodies related to agent technologies.

Description of work

This workpackage serves as a focal point for co-ordinating and integrating the defined cognitive and affect components which are required to implement affective computing in real-time multi-agent applications. It is also in this workpackage that a framework for enriching interactions and applications with an affective dimension will be designed. This framework will provide some guidelines for enriching applications with affective interaction and methodologies for developing affective real-time multi-agent systems. Which will be subsequently used for the demonstrators developed in workpackage 6. Workpakage 3 will serve to provide the input sensory components required for affective real-time mulit-agent applications; workpackage 4 will provide the internal computational mechanisms for reasoning, learning and affective planning required for affective agent behaviour; whereas workpackage 5 will express the agent behaviour through different modalities. The results achieved in these workpackages will be integrated through the use of common APIs as a set of tools resulting in a toolkit for affective real-time multi-agent system development.

Deliverables

D2.1 (M10) Specification of the components of the toolkit with functional description and API
D2.2 (M13) Specification of the framework and first prototype of the affective toolkit software package (draft version)
D2.2 (M19) Specification of the framework and first prototype of the affective toolkit software package (final version)
D2.3 (M26) Final specification of the framework and final version of the affective toolkit software package

Milestones and expected results
M4 Overview and comparison of current architectures
M7 First kernel API for toolkit components
M10 Final kernel API for toolkit components
M13 First prototype of toolkit software package
M13 First framework specification for use of the affective toolkit
M19 Final framework specification of the framework for the affective toolkit
M26 Final prototype of toolkit software package

B3.	Workpackage description			
Workpackage number :	3			
Start date or starting event:	Month 4			
Participant number:	**1**	2	4	5
Person-months per participant:	**6**	3	3	3

Objectives

- Classify and test different types of input that will capture human affect.
- Specify and construct a component that will analyse user's behaviour with affective objects aiming its integration in the toolkit.
- Extend current user modelling techniques to represent affect and personality of the user. Specify and develop a shell for affective user modelling.

Description of work

Sensors are one important part of an affective application since they can provide information about the user's behaviour or physical state. In this work package a set of problems dealing with perception and emotion will be handled and, as a result, a set of tools for performing affective sensing will be provided.

Deliverables

D3.1 (M16) Shell for affective input
D3.2 (M19) Shell for user affective modelling

Milestones and expected result

M7 First specification of the shell for affective input through objects
M7 First specification of the shell for user affective modelling
M12 First prototype of shell for affective input
M12 First prototype of shell for user affective modelling
M18 Final prototype of shell for affective input
M20 Final prototype of shell for user affective modelling

B3.	Workpackage description						
Workpackage number :	4						
Start date or starting event:	Month 0						
Participant number:	1	**2**	3	4	5	6	7
Person-months per participant:	4	**10**	2	4	2	5	1

Objectives

- To produce a survey and analysis of theories of emotion to be used for synthetic emotions in autonomous agents.
- To create a model of the development and evolution of emotions.
- To build a computational tool to define and implement the appraisal components of synthetic characters.
- To build a computational tool to be used to define and implement emotion-dependent decision making, planning and action selection mechanisms.

Description of work

This Workpackage will handle the problem of how to embed emotion and cognition in a machine (being it a synthetic character, an agent or a robot). The overall goal is to develop technologies that can be put together to build a machine that can exhibit both emotionally controlled behaviour and emotionally expressive behaviour grounded on its internal architecture.

Workpackage 4 is focused on the internal mechanisms and structures that can be used in a synthetic character to support affective phenomena like emotion and the relation between emotion and cognition. This includes the definition and implementation of appraisal capabilities (i.e., the process by which an agent evaluates each situation with respect to its values, motives and attitudes and generates emotions), the definition and implementation of emotion-controlled decision making, planning and other action selection processes, and the definition and implementation of mechanisms responsible for emotion evolution and development.

Deliverables

D4.1 (M7) Abstract specification of emotion and appraisal to be used within the framework

D4.2 (M20) Shell for emotional processing and emotional evolution

Milestones and expected result

M4 Overview of applicable psychological models of emotions

M7 Definition of emotion and appraisal for framework and toolkit

M9 First specification of the shell for emotional processing

M9 First specification of the shell for emotional evolution

M12 First prototype of the shell for emotional processing and emotional evolution

M20 Final prototype of the shell for emotional evolution and processing

B3.	Workpackage description			
Workpackage number :	5			
Start date or starting event:	Month 4			
Participant number:	1	3	**4**	**5**
Person-months per participant:	8,3	9	**11,7**	**5**

Objectives

- Development of APIs and plug-ins to allow agents who are dynamically changing their behavior and emotional state to communicate their emotions through existing facial animation packages.
- Development of tools to support the expression of emotions and personality through body movement.
- Development of tools to generate drawings in real-time which reflect an agent's emotions and personality.
- Development of tools and techniques to use linguistic style to express emotion and personality.

Description of work

This workpackage develops techniques to allow agents to express emotions and personality in ways that are perceptible to users. We will develop these techniques for four modalities of communication: facial expression, bodily expression, drawing, and natural language. The techniques and tools developed will be integrated in the architecture of WP2 so that they can be used to express the emotions modelled in WP4.

Deliverables

D5.1 (M10) Specification of shell for emotional expression
D5.2 (M22) Shell for emotional expression

Milestones and expected results

M7 First specification of the shell for facial expression
M7 First specification of the shell for body expression
M7 First specification of the shell for affective rendering
M10 First specification of the shell for affective speech and natural language
M12 First prototype of the shell for facial expression
M18 First prototype of the shell for body expression
M12 First prototype of the shell for affective rendering
M18 Final prototype of the shell for affective inter-agent communication
M15 First prototype of the shell for affective speech and natural language
M22 Final prototype of the shell for facial expression
M22 Final prototype of the shell for body expression
M22 Final prototype of the shell for affective rendering
M22 Final prototype of the shell for affective speech and natural language

B3.	Workpackage description		
Workpackage number :	6		
Start date or starting event:	Month 13		
Participant number:	**1**	4	5
Person-months per participant:	**10**	1	10

Objectives

This Workpackage has as main goal to demonstrate the use of the technology developed in the other workpackages through the construction of a set of demonstrators.

For each one of the demonstrator, there will be an initial study of the theories and types of emotions that may occur in these scenarios as well as the components used for the agent's architectures. We will develop three demonstrators:

- the Influencing Machine (integration);
- an augmented realities 3D Fantasy world (FantasyA);
- an affective personal assistant (James the Butler).

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Description of work

The work package comprises the design, development of each of the three applications. The work package consists of three tasks:

1. Design and development of the Influencing Machine application.
2. Design and development of the Affective Toys World application.
3. Design and development of the affective personal assistant.

Deliverables

D6.1 (M20) Prototype of the demonstrators for evaluation

D6.2 (M25) Final prototypes of the demonstrators

Milestones and expected result

M16 Specification of the Influencing Machine application
M16 Specification of the affective toys world application
M16 Specification of the affective personal assistant
M19 First prototype of the Influencing Machine application for evaluation
M19 First prototype of the affective toys world application for evaluation (FantasyA)
M19 First prototype of the affective personal assistant for evaluation (James the Butler)
M22 Final prototype of the Influencing Machine application for evaluation
M25 Final prototype of the FantasyA application for evaluation
M25 Final prototype of the affective James the Butler for evaluation

B3.	Workpackage description					
Workpackage number :	7					
Start date or starting event:	Month 7					
Participant number:	1	2	4	5	6	**7**
Person-months per participant:	4	1	2	1	5	**10**

Objectives

The main goal of this workpackage is to evaluate the impact that the affective components will have in the interaction with the users. Each of the applications will be evaluated in the process of embedding affective components and in the interaction established with users.

Description of work

The evaluation of the SAFIRA approach will be done in two ways:

1. by evaluating the framework and toolkit through the analysis of the process of embedding the affective components in applications; and
2. by evaluating the impact that such affective components have on the developed demonstrators which utilise affective reasoning and emotion-based interactions.

Deliverables

D7.1 (M11) Evaluation plan
D7.2 (M20) Joint report on experiences and recommendation for affective interaction
D7.3 (M26) Final evaluation report

Milestones and expected results

M13 Evaluation of the first framework specification
M20 Evaluation of the first prototypes demonstrators within the first framework specification
M26 Final evaluation of the demonstrators within the final framework specification

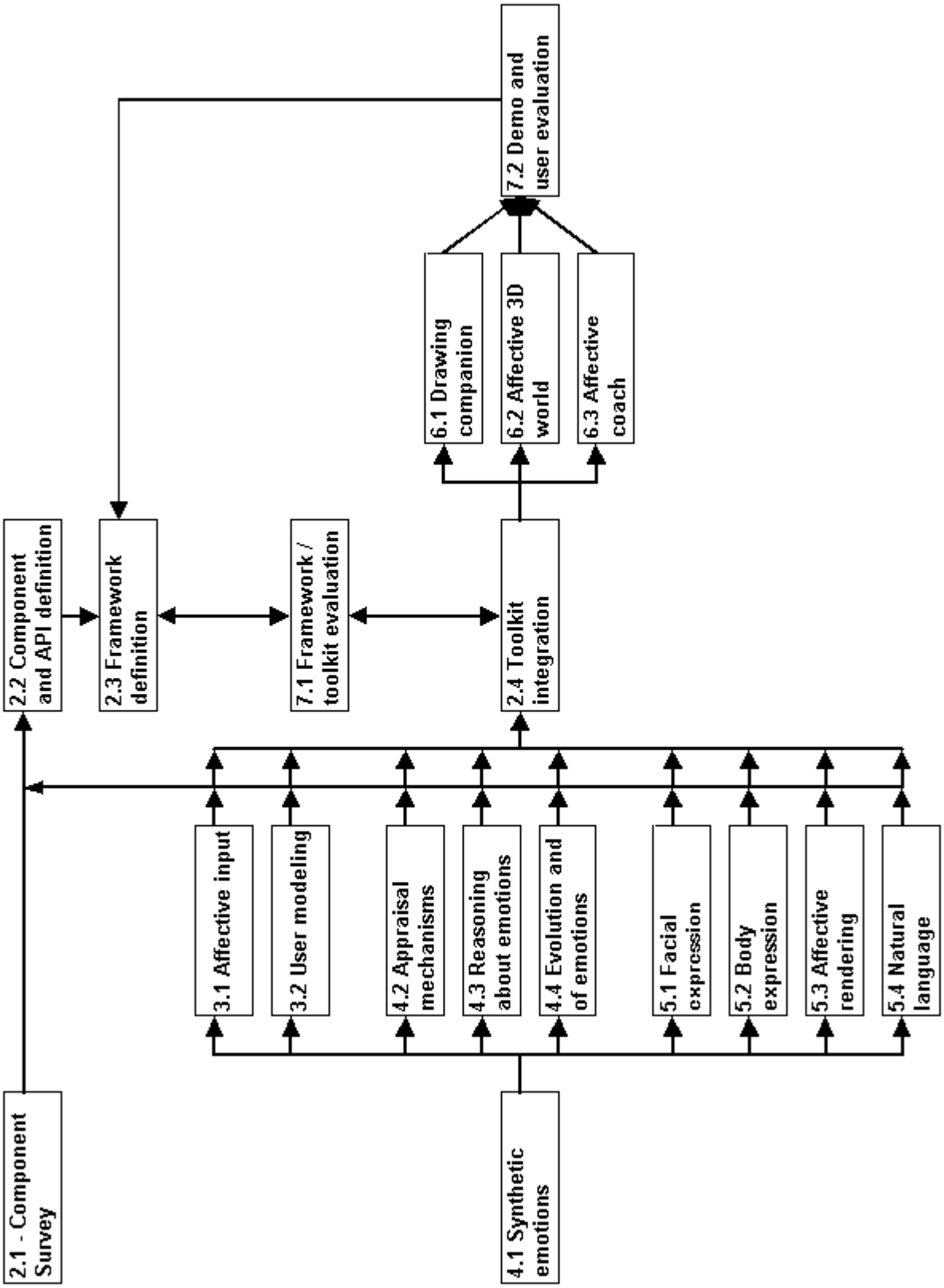
9.12 Deliverables list

Del. no.	Del. Name	WP no.	Lead participant	Estimate person-months	Del. type	Security *	Delivery (proj. month)
1 (D4.1)	Abstract specification of emotion and appraisal to be used within the framework	4	2	10	R	Pub	7
2 (D2.1)	Specification of the components of the toolkit with functional description and API	2	5	5	R	FP5	7
3 (D5.1)	Specification of shell for emotional expression	5	4	13	R	FP5	10
4 (D7.1)	Evaluation Plan	7	7	4	R	FP5	10
5 (D2.2)	First specification of the framework and first prototype of the affective toolkit software package	2	5	13	R	FP5	13
6 (D1.1)	Quality Assurance Report	1	1	3,5	R	Pub	13
7 (D3.1)	Shell for affective input	3	1	7	P&R	Pub	16
8 (D3.2)	Shell for user affective modelling	3	1	8	P&R	Pub	19
9 (D6.1)	Specification and First Prototype of the demonstrators for evaluation	6	1	9	P&R	FP5	20
10 (D7.2)	Joint report on experiences and recommendation for affective interaction	7	7	10	R	FP5	20
11 (D4.2)	Combined Shell for emotional processing and emotional evolution	4	2	18	P&R	Pub	22
13 (D5.2)	Shell for emotional expression	5	5	21	P&R	Pub	23
14 (D6.2)	Final prototypes of the demonstrators	6	1	10	P&R	Pub	25
15 (D7.3)	Final evaluation report	7	7	7	R	Pub	26
16 (D1.2)	Quality Assurance Report	1	1	3,5	R	Pub	26
17 (D2.3)	Framework and final version of the affective toolkit software package	2	5	8	P&R	Pub	26
18 (D1.3)	Web site for toolkit dissemination	1	1	4	P&R	Pub	26

**Int.* *Internal circulation within project (and Commission Project Officer if requested)*
Rest. *Restricted circulation list (specify in footnote) and Commission PO only*
IST *Circulation within IST Programme participants*
FP5 *Circulation within Framework Programme participants*
Pub. *Public document*

9.13 Project planning and timetable

9.14 Graphical presentation of project components



9.15 Project management

The project is structured in a way which makes Project Management functions clear and verifiable. The project workplan has been structured so that dependencies between workpackages and between tasks are clear and enabling the executing of parallel tasks. Monitoring the project's work and progress through the definition of milestones based on these dependencies is facilitated by this structure. Each workpackage addresses a well-specified and coherent set of tasks (see sections above), allowing it to concentrate on major results and deliverables to dependent workpackages.

The management team, the Project Management Board (PMB) is made up representatives from all partners plus the Project Manager. The role of the PMB is to decide on operational and management issues of the project. There will be also a Technical Board (TB), that includes, representatives from the Workpackage Leaders (WPL) and, for those partners without a WPL, a nominated Technical Manager.

This structure, allows rapid decision making on both operational and technical issues, while maintaining the essential mechanisms for consensus management on project strategy and of other decisions relating to the consortium as a whole.

The **Project Management Board**, chaired by the Project Manager, functions are:

- to define and monitor project policy;
- to decide any actions necessary to correct potential deviations from the project plan, both technical and financial;
- to discuss and resolve contractual matters, among partners, as well as with the Commission;
- to approve annual and quarterly plans;
- to receive Technical Board reports on technical direction, quality, liaison and promotion activities and decide on any adjustments to be implemented by the Technical Board.

The **Technical Board**, also chaired by the Project Manager will be responsible for the implementation of project policy, liaison and external activities of the project, and technical quality management and control, in particular to:

- review content and quality of project deliverables;
- review deliverables and reports from external delivery;
- plan project external presentations;
- provide technical assessment of future partner and project plans;
- plan and carry out the dissemination of results.

The project will have **quarterly full partner meetings**. These meetings will be used to disseminate technical progress through presentation of results and peer review, co-ordinate and cohere project planning, and allow serendipitous discovery of new perspectives and ways of making progress through inter-disciplinary interaction. Meetings of the Technical Board and the Project Management Board will be convened at full partner meetings: however this does not rule out interim meetings of workpackages or extraordinary meetings of either Board if demanded by circumstances.

For the purposes of **quality assurance** and ensuring that partners' goals and interests are respected throughout the project, consensus in decision-making is extremely desirable. The existing collaborations and mutual respect between partners will be invaluable in ensuring constructive dynamics within the project. **Peer review will then be the main mechanism for providing quality assurance.** However, because the project is tackling issues which are open-ended, far-reaching and inter-disciplinary, there is a risk of disagreement. **Therefore, conflicts will be managed by an agreed alternative mechanism for decision-making where consensus is difficult**. In such cases, the Project Management Board will consider the issues in such situations and decide which course of action is best for the project. The PMB will take into account recommendations from the Technical Board, but will have the final decision regarding policy and direction of the project.

Operational decisions will be the responsibility of Workpackage Leaders and co-ordinated through the Technical Board. Administrative issues will be dealt with through the Project Manager. In the final reckoning, a **Consortium Agreement** will be used to resolve differences.

A **Project Quality Plan** will be produced by the Technical Board at the beginning of the project and will define items such as: document format and standards; deliverable review procedures; inter-project communication format; partner co-ordinates for communication; reporting and meeting formats; and financial Procedures. These decisions will be documented in a Project Handbook.
A **document numbering and registration system** will be used. This will be an electronic system where any partner can request a document number at any time and a register of available documents is automatically maintained. Document distribution will also be primarily by electronic means (except for documents where electronic versions are unavailable or for legal documents).
Information flow in collaborative projects of this nature is crucial to technical progress and good working relationships. The issue has been considered carefully by the consortium. The overriding criterion must be that information flow can only be achieved through methods which are easy to use but highly effective and ubiquitous. The Co-ordinating Partner has undertaken that these mechanisms will be put in place prior to the commencement of the project to ensure a rapid start-up to the project and smooth execution during the project lifetime.
Email reflectors will be established for the overall project, the Boards, and also one for each workpackage. Others may be set up as required. Between meetings, Email and ICQ will be used as the primary form of communication and exchange of documents between the project team.
A **WWW site** will be established for internal and external communication purposes. The WWW site will have an FTP gateway to allow partners to upload documents. The "public" portion of the site will contain a general description of the project with contact information, public documents and occasional status reports designed for external purposes. A "private" portion will be password protected and used mainly for the exchange of internal documents, including document registration, and software. Downloading may be performed by FTP or WWW.
The partner representative on the PMB will ensure that administrative information flows are open, which enable overall project health to be monitored at regular intervals. **Project reporting mechanisms** will specifically include a monthly control report (detailing person-months expended, achievements made in terms of results and progress, meetings attended, plans, for next period, and issues arising and their perceived seriousness). PMB members will also contribute to the annual review report, annual cost claim and delivery of the final report.
Much of this information is used in preparing the **report for the Project Officer**. All of it is useful to the project management (especially the PMB) and so these reports will be distributed to its members via the e-mail reflector. Asking the partners to report their plans for the coming month allows the PMB or individual workpackage leaders to make corrections to the work plan in a pre-emptive manner and to ensure efficient use of resources.
In addition to reporting to the Commission, the Project Manager will co-ordinate other **external liaisons**, including any contribution to any horizontal actions, project clusters and programme meetings. Relevant work will be submitted to appropriate standardisation and regulatory bodies, and publication of research results in scientific forum will be encouraged.

10 Appendix A – Consortium description

This project brings together almost all the leading research teams in the area of affective computing in Europe, with a view to making the most of all the skills available within a single project. Some of the best European Research Institutes that embrace expertise from in Computer Science in general, AI, Computer Graphics, Human/Computer Factors, Psychology and Philosophy are present in this project. The main thread uniting the various elements is that all of them recognize the need to consider affective interactions between humans and computers and have worked intensively in affective interactions, personality and emotion-based architectures for autonomous agents. However, each partner brings to the consortium its own specific topic of expertise within this new research and development area (as illustrated in the Table 1).

No.	Participant	Main expertise brought into the project	Technical Role in the Project
1	INESC-ID &INESC	Intelligent Agents in Virtual Environments, User Modeling and Affective Acquisition, Planning and Emotions	Affective Acquitision and Affective User Modelling; Affective Planning; Fantasy World Demonstrator
2	ADETTI	Emotion-based Architectures	Emotion-based Architecture and Affective Decision Making
3	DFKI	Natural Language Interaction	Affective Natural Language Expression
4	GMD & FhG/IMK	Expressive behavior in autonomous agents, Machine Learning	Affective Expression ; Learning with Emotions; Influencing Machine Demonstrator
5	ICSTM	Multi-agent Systems, Inter-Agent Communication, Personality in Human Computer Interaction	API. Toolkit Integration; Role of Personality in the interaction; Personal Assistant Demonstrator.
6	OFAI	Philosophical and Psychological Theories of Emotion, Augmented Reality	Theories of Emotion to support the affective interactions toolkit.
7	SICS	Human/Computer Interaction, Evaluation, User Modeling	Evaluation

Table C.1 – Partners Expertise and Technical Roles

The roles of each partner is as follows: all partners cover the management of the project, through their representation in the Management Board; all the partners contribute to the development of components to the toolkit for affective computing specified in the workplan; each one of the partners is responsible for one or more research and development topics essential to the area of affective computing. The APIs and toolkit integration is of responsibility of all partners with co-ordination of the Imperial College team. The evaluation is responsibility of SICS. The general management of the project is the responsibility of INESC.

The representatives of each consortium member are generally well known to each other, and for the past few years they have been interacting through the participation and organisation of workshops and conferences, or through participation in European projects.

Finally, since this project does not intend to bring a new product into the market, but rather to bring to the European software community a new enabling technology, there are no industrial partners in the project. Commercialisation of the software will be done by industrial partners of the consortium members within complementary projects, such as a large joint project on intuitive multimodal

communication carried out by DFKI and leading German and international companies, including Daimler-Chrysler AG, Philips GmbH, Siemens AG, and Sony International.

Description of the Participants

Seven research institutions are cooperating in this proposal: INESC and ADETTI from Portugal, DFKI and GMD from Germany, IC from the United Kingdom, and OFAI from Austria. Here, we will look at each of these institutions and their major participants in more detail.

10.1 Instituto de Engenharia de Sistemas e Computadores (INESC)-ID

10.1.1 Organisation

INESC-ID is a research Institute created by a restructure of INESC in 2001. INESC - Instituto de Engenharia de Sistemas e Computadores (Institute for Systems and Computer Engineering) is a private, non-profit association, dedicated to research, technological development, technology transfer and advanced training in information technologies and telecommunications. INESC was legally incorporated in August 1980; (following a joint executive order between the Ministry of Transports and Communications and the Ministry of Education, published in the DR Nº 167 of July the 22nd 1980). Recognition of its research activity has led the Prime Minister to declare INESC as an Institution of Public Interest on 6 February 1987.

Since its creation, INESC has succeeded in finding the organisational formulas that enabled it to tackle the tremendous increase of activities, fruit of the continuous enlargement of R&D activities and advanced technological professional training, allowing it to maintain a high level of productivity both in R&D and in service supplying. Throughout its existence, INESC has developed R&D and technological training activities, in what has become a model of University-Industry relationships, being the first institution in Portugal to show that even in a less developed country, Research and Development has its worth and place in the social-economic context. Nowadays the INESC model is a paradigm of the University's bonds with the outside world, combining the enterprise management's rigour with the university environment and scientific creativity in a flexible institutional way. Innovation would not occur if such links were impossible.

Innovation and Technological Transfer has always been considered as a key field of INESC's action. It is well-known for its importance in creating and increasing the value of the portuguese SME's, with which the institution maintains close links through various contracts of technical and specialised assistance. In addition, INESC has applied for a group of supporting actions in the PEDIP (Specific Programme for the Development of the Portuguese Industry), which aim at the establishment of several demonstration units and technology transfer centres, for the reinforcement of its technological transfer capacity towards portuguese companies. If, as seems likely, PEDIP supports INESC’s proposal, INESC will be able to maintain an important and continuing technological transfer capacity towards the industrial activity in Portugal. So, industry will find in this institution the privileged interface, through which they gain easy access to creativity, innovation, methodologies, and even prototypes of high commercial value and specialised knowledge capable of recommending present and future action, as well as to specialised know-how.

In fact, INESC combines an entrepreneurial management with academic creativity which results in a special institutional flexibility. Scientific research and technological development activities are currently structured in four scientific-technological areas: telecommunications and new services, computers and informatics, electronic systems and technology, and computer integrated manufacturing. Each area is chosen to have strategic character and be pertinent to current scientific-technological domains of activity.

INESC has participated and is participating in quite a few European projects and initiatives: ESPRIT (44 Projects), RACE (3 Projects), EUREKA (4 Projects), BRITE/EURAM (2 Projects), DELTA (2 Projects), SFS/NATO (2 Projects), SPRINT (participation in 3 Projects being evaluated by the Commission), AIM (4 Projects), COMETT (2 Projects), COMAC/BME (2 Projects), SCIENCE, COST, CTS, Y-NET, JESSI, OMI, ESSI. These strengthen and increase INESC's

institutional connections at an international level; for example, in the first semester of 1990, INESC maintained connections with 50 partners in the U.K., 50 in France, 35 in Italy, 28 in Germany, and 16 in Denmark. These data underscore the fact that INESC is integrated in an international institutional network of great relevance, with supported links in a strong field of personal relationships between its researchers and their project colleagues from other institutes in other countries. INESC can be found on the Web at www.inesc.pt.

10.1.2 Participants

Professor Ana Maria Severino de Almeida Paiva is a senior research member of INESC and a Professor at Instituto Superior Técnico. She is well known in the area of User Modelling and Artificial Intelligence Applied to Education. After her PhD in the UK at the University of Lancaster, she has worked in Germany (GMD) and in France (CNRS-COAST team at the ENS of Lyon). Her research now is focused on the use of autonomous agents as life-like characters for interaction with users. She has participated in many committees of international conferences (EuroAIED'96, AIED'99, CATE'98, CATE'99) and workshops and was one of the co-chairs of the 1996 European Conference on Artificial Intelligence in Education. Currently she is co-ordinating several Computer-Based Learning projects in collaboration with Universities, industry and schools. She was the co-ordinator in the participation of INESC in the European project IDEALS (funded under the Telematics program) and currently the I3-ESE project NIMIS.
Professor Mário Rui Fonseca dos Santos Gomes is Professor of Computer Graphics and User Interfaces at the Instituto Superior Técnico. Mário is also heading the Group of Interactive Environments for Visualization and Learning, GAIVA Research Group at INESC. From 1991 to 1997, he was also the Coordinator of INESC´s Multimedia Center. He obtained his M.S. in 1984, his PhD in 1991 and his Aggregation in 1998, all at Instituto Superior Técnico. Professor Gomes has been a member of the Programme and Organising Committees of several national and international conferences. He has been involved in different National (JNICT, PEDIP, PITIE), European (CTS/2 (CGI), DELTA (DEDICATED), TELEMATICS (IDEALS), ACTTS (RESOLV) and ESPRIT(INTERACTORS, TEN-PRO)) and International Projects (SFS/Nato (PO-SHOECAD)). Professor Gomes is a founding member of the WG5.10 on Computer Graphics of IFIP TC5, a member of IFIP TC13 on Human-Computer Interaction and a member of the Portuguese Technical Committee for Standardisation on Computer Graphics - CT 109. He is also a member of Ordem dos Engenheiros, ACM, ACM-SIGGRAPH and Eurographics.
Carlos António Roque Martinho is a PhD student at Instituto Superior Técnico (IST) of the Technical University of Lisbon and a research assistant at INESC. His main research interests are synthetic personality and emotions. In his master's thesis entitled "Emotions in Motion", he developed an architectural framework for real-time intelligent virtual environments with emotionally driven autonomous agents, which was used to create an underwater world featuring two dolphins (Expo´98) that was presented at main international conferences and published in international journals.

10.2 Associação para o Desenvolvimento das Telecomunicações e Técnicas de Informática (ADETTI)

10.2.1 Organisation

ADETTI, the Associação para o Desenvolvimento das Telecomunicações e Técnicas de Informática, is a non-profit research institution created in 1989. It concentrates the research activity of lecturers and professors of the Information Sciences and Technologies Department of ISCTE (Instituto Superior das Ciências do Trabalho e da Empresa), a public University in Lisbon. ADETTI has presently a staff involved in research work that includes 7 PhD's 11 MSc's and 6 MBA's, as well as a number of PhD and MSc students. A large number of undergraduate students are also involved in ADETTI in the scope of their final work for graduation.
The main activities of ADETTI are as follows:

- • Research on Advanced Telecommunications Systems;
- • Research on Telecommunication Networks;
- • Research and development in Computer Graphics (specifically, 3D Computer Animation and CAD systems for the Apparel Industry);
- • Research and development on Multimedia systems;
- • Development and support of Information Systems;
- • Research on Information Technologies for Management Sciences.
- • Research on Intelligent and Communication Integrated Systems

ADETTI is oriented towards a direct collaboration with other research and university institutions, as well as industries. Relevant work has been developed in the areas of CAD and CIME to enhance the technological level of the Portuguese manufacturing industry (project ROBLAS) under contract with the Portuguese Ministry for the Industry. In the information security domain, ADETTI has participated in the ACTS Projects OKAPI and OCTALIS, where it has developed specific tools for conditional access to multimedia services and IPR management and protection.

ADETTI has a Computer Graphics and Telecommunications laboratory, with Sun Workstations; Silicon Graphics INDIGO, INDY and O2, several multimedia computers, Linux and Windows NT4.0 file servers, and a Beowulf Network Cluster for parallel computing research. ADETTI has also available at its premises a 2 Mbit/s connection to the Lisbon DQDB-MAN, and a 34 MBit/s ATM connection to the Portuguese National Host.

ADETTI has a significant participation in RTD European programs (ACTS, Ten-IBC, Cost, Esprit, Telematics), and has been a partner in several projects concerning 3D Modelling Design tools and systems, conditional access to multimedia systems, Intellectual Proprietary Rights management and protection, broadband networks and tools for co-operative work. Our major projects and partners in them are as follows:

- **TEN IBC, ”FASHION NET/ TEMIN”:** Fashion Net seeks to investigate the use of broadband communications for teleservices and teleco-operation in the fashion industry. Partners: CPRMarconi, Trinity College, Citer - Italy, FhG-IAO – Germany, Maconde – Portugal, ENEA – Italy, CAD Modelling – Italy.
- **TEN IBC, ”VISINET”:** Visinet seeks to demonstrate the use of advanced 3D design systems in the context of shared environments across broadband networks, and investigate the extent to which collaboration using virtual representation reduces product lead times and increases overall product quality. Partners: Portugal Telecom - Portugal, EDC - European Design Centre – Netherlands, Univ. Leeds - England, Analysys – England, Philips, Intergraph, Androme, Alcatel Bell
- **TEN IBC, ”ARTLINE”:** At a technical level the emphasis of the Artline Project will be to test the latest ATM communication links. At a comercial level the project will test assumptions about the delivery of a "value added" European arts information service examining questions of consumer preference and price sensitivity. Partners: Trinity College, FhG-IAO, CPAI, AXIS
- **ACTS, ”OKAPI (**Open Kernel for Access to Protected Interoperable interactive services)”: The OKAPI project has the goal of designing, testing, and disseminating an equitable, open and interoperable kernel for the distribution of future multimedia services in different countries. The last step to reach this goal is the acceptance of this kernel as a standard. Partners: University Catholique Louvain, FID, UT
- **TELEMATICS, ”MAID** (Multimedia Assets in Industrial Design)”: The MAID Project will design and test a range of high level multimedia services, and demonstrate economically justified and professionally effective tools for the design and product development industry. The project aims at improving the competitiveness of the design-based industries and professions. Partners: European Design Centre, Oficina de Arquitectura, INESC, Novo Disegn, CITE, AIVE, CEDIMA
- **ESPRIT, ”AITEAR (**Advanced IT Infrastructure for Accurate response in the Extended Enterprise)”: IT Infrastructure in support of Accurate Response Manufacturing in the textile and

garment manufacturing industry. Partners: ENEA-CETMA, FhG-IAO, TCD, Kewill Systems, Maconde, SIII, CIMI, Al Ferano, Citer, Marzotto, Tekne

- **ACTS, "OCTALIS (**Offer of Contents Through Trusted Access Links)": The main goal of the OCTALIS project is to integrate a global approach to equitable conditional access and efficient copyright protection and to demonstrate its validity on large scale trials. The OCTALIS project will rest on previous results obtained in access management through smart-cards and Trusted Third Parties (TTPs) network and in the copyright protection through watermarks and appropriate labels. Partners: University Catholique Louvain, FhG –IGD, BFF, RTBF, EBU, TCC, AVELEM; INA, MediaRede, CPAI, Arthouse, CTS, BBC, EPFL, CCETT, CSELT
- **ESPRIT, "CODEC (**Multiwavelet Video Compression)": In this project the aim is to develop a revolutionary, new class of video compression algorithms that will form the basis of the standards of the next century. Our approach will be to use the multiwavelets transform in space and time with a space-time extension of the zero-tree algorithm commonly used in image compression. Partners: University of Balearic Islands
- **ACTS, "MODEST (**Multimedia Object Descriptors Extraction from Surveillance Tapes - Intelligent Agents)": The objective of the MODEST project is to define and develop a framework for analysing video sequences in order to obtain high-level semantic scene interpretation. Its technical approach is to segment, track and index, in a cooperative way, moving objects in video scenes. Results will be demonstrated on a video surveillance application. Partners: University Catholique Louvain, LEP, EPFL
- **ESPRIT, "M3D (**Multi-site Cooperative 3D Design System for Architecture)": The objective of the project is to integrate the CAD technology with the VR and high performance network technology to be a prototype multi-site cooperative 3D system for architecture design. The foreseen prototype system will extend the major functions of the single user CAD architecture design tools to a networked cooperative system at multiple locations. Real time interactive cooperative design with audio/video conferencing will be realised in the system with other off-line functions. Partners: University of Balearic Islands, European Design Centre, Oficina de Arquitectura, IDOM, ARQMAQ

In addition to these EU project activites, Prof. José Guimarães is the National Representative for Action Line COST 264 – "Multimedia & Internet Communications", and was the National Representative for Action Line COST 237 – "Multimedia Telecommunication Services." ADETTI is also a member of the standards organizations FIPA (Foundation for Intelligent Physical Agents), OPIMA (Open Platform Initiative for Multimedia Access), and DIG (Digital Imaging Group).

10.2.2 Participants

Professor Luis Miguel Botelho is an Assistant Professor of the Department of Information Sciences and Technologies of ISCTE and senior researcher of ADETTI, with a PhD and MsC in Artificial Intelligence. His PhD thesis ("Building intelligent agents: an approach based on the cognitive models of decision making") explores the definition of agent models that capture the relationship between affect and cognition in decision making and action. Professor Botelho has published several papers in international workshops, conferences and journals, including about artificial emotions. He participates in the MODEST Project (ACTS AC-304), where he is responsible for inter-agent communication and for visual tracking of mobile objects between cameras. His main research interests are artificial emotions and multi-agent systems.

Dr. Pedro de Paula Nogueira Ramos is a Lecturer at ISCTE since 1988, working in the Department of Information Sciences and Technologies, and a senior researcher of ADETTI. He has a Master's degree and PhD in Artificial Intelligence. The main topic of his PhD research is Formal Organisations Analyses. Currently, his main research interest is the analysis of how emotions influence the behaviour of agents, specifically in the decision making process in organisations. He has published one paper in an international journal, one chapter of a book and three papers in international conferences. He has supervised several projects for process automation in organisations and general information systems.

Dr. Joaquim António Marques dos Reis is a Lecturer of the Department of Information Sciences and Technologies of ISCTE and senior researcher of ADETTI. He has a PhD and MsC in Artificial Intelligence. In his PhD thesis (”Multi-Agent Coordination and Communication for Scheduling”) he explores an emotion-based mechanism through which an intelligent agent can improve its scheduling strategy. He has published several papers in national and international workshops, conferences and journals. His research areas include Artificial Intelligence, communication and coordination in Multi-Agent Systems, and Scheduling, particularly including the influence of emotion in scheduling.
Professor Carlos Manuel Gutierrez Sá da Costa is a Professor at Instituto Superior Técnico. He is well known in the area of Telecommunications. After his PhD in the UK at the University of Essex, he has worked in (INESC and Instituto das telecomunicações, IT. His research now is focused on wireless telecommunications. He has participated in many international workshops and conferences. Currently he is co-ordinating several Telecommunication Management projects in collaboration with Universities and industries.

10.3 Deutsches Forschungszentrum für Künstliche Intelligenz (DFKI GmbH)

10.3.1 Organisation

Founded in 1988, DFKI today is one of the largest nonprofit contract research institutes in the field of innovative software technology based on Artificial Intelligence (AI) methods. DFKI is focusing on the complete cycle of innovation - from world-class basic research and technology development through leading-edge demonstrators and prototypes to product functions and commercialization. Based in Kaiserslautern and Saarbrücken, the German Research Center for Artificial Intelligence ranks among the important "Centers of Excellence" worldwide.
An important element of DFKI's mission is to move innovations as quickly as possible from the lab into the marketplace. Only by maintaining research projects at the forefront of science can DFKI have the strength to meet its technology transfer goals.
DFKI's five research departments are directed by internationally recognized research scientists:

- Information Management and Document Analysis (Director: Prof. A. Dengel)
- Intelligent Visualization and Simulation Systems (Director: Prof. H. Hagen)
- Deduction and Multiagent Systems (Director: Prof. J. Siekmann)
- Language Technology (Director: Prof. H. Uszkoreit)
- Intelligent User Interfaces (Director: Prof. W. Wahlster)

There is an additional subgroup, the "Siemens Tele-Cooperation Center" (Siemens Telekooperationszentrum (STZ)) that is part of the "Intelligent User Interfaces" department. The key directors of DFKI are Prof. Wolfgang Wahlster (CEO) and Dr. Walter G. Olthoff (CFO).
At DFKI, all work is organized in the form of clearly focused research or development projects with planned deliverables, various milestones, and a duration from several months up to three years. DFKI benefits from interaction with the faculty of the Universities of Saarbrücken and Kaiserslautern and in turn provides opportunities for research and Ph.D. thesis supervision to students from these universities, which have an outstanding reputation in Computer Science.
DFKI has also successfully conducted a number of projects for the European commission under the programmes ESPRIT, TELEMATICS, and Networks of Excellence. Furthermore, it has been playing a major role in the VERBMOBIL project, which is considered to be one of the largest projects on machine translation world-wide.
In SAFIRA, DFKI's Intelligent User Interfaces (IUI) department will be involved. Research in this department focuses on intelligent information assistants, multimedia authoring tools, multimodal interfaces, telecooperation systems, natural-language systems and lifelike characters. The department has a great deal of experience in the coordination of and participation in various EU research projects, such as FLUIDS, MATE, MLOUNGE and PUPPET. Since 1994, the department has been engaged in the development of animated interface agents. Such agents go far beyond conventional interfaces, since they promote the emerging paradigm shift from direct manipulation

to highly personalized interfaces. The group has been conducted a number of industrial and academic projects on lifelike agents including the following:

- *The BMBF-funded project PPP (Personalized Plan-Based Presenter):* With the PPP Persona, the group developed one of the first virtual presentation agents world-wide. This system is based on DFKI's award-winning presentation planning technology (IT Prize 1995).
- *The BMBF-funded project AiA (Adaptive Communication Assistant for Effective Infobahn Access):* With the Persona-Enabling Toolkit PET, the group provides a software package for the creation of lifelike characters which can easily integrated into web interfaces. Based on this toolkit, the group developed a number of innovative web applications, such as virtual shopping assistants or travel guides.
- *The EU-funded i3-ese project Puppet (The Puppet Theatre of Virtual Worlds):* Puppet explores new forms of learning by the development and evaluation of novel interactive virtual environments.

Today, the group is considered to be one of the leading research teams in the area of animated interface agents. This is reflected by numerous publications and invitated talks at major conferences. Furthermore, the group has organized a number of workshops on animated interface agents, e.g. at IJCAI 97 in Nagoya or the i3 Spring Days in Barcelona in 1999. Members of the group have also been editing a Special Issue on Animated Interface Agents for the Applied Artificial Intelligence Journal [André 99] and a Special Issue on Intelligent Information Agents for German Artificial Intelligence Journal [André/Rist 98]. Reports on the group's work have also appeared in a number of newspapers and magazines, such as Computerzeitung, Handelsblatt, Le Monde and Science et Vie. The DFKI can be visited on the web at http://www.dfki.de.

10.3.2 Participants

Dr. Elisabeth André is a principal researcher at DFKI GmbH. She has been leading various industrial and academic projects in the area of intelligent user interfaces, including the BMBF-funded projects PPP and AiA, DFKI's part of the GIF-funded project IMAP and DFKI's part of the EU-funded i3-ese project Puppet. She is the Chair of the ACL Special Interest Group on Multimedia Language Processing (SIGMEDIA). Furthermore, she is on the Editorial Board of Artificial Intelligence Communications (AI COM) and the Area Editor for Intelligent User Interfaces of the Electronic Transactions of Artificial Intelligence (ETAI).

10.4 GMD Forschungszentrum Informationstechnik GMBH (GMD)

10.4.1 Organisation

The GMD National Research Centre for Information Technology is the premier national center for computer science research in Germany. It is a non-profit, limited liability private company (GmbH), whose shareholders are the Federal Republic of Germany (90%) and the Federal States of North Rhine-Westphalia (3,3%), Hesse (3,3%) and Berlin (3,3%). The GMD conducts research in the following key areas of information technology: system design technology, intelligent multimedia systems, communication and cooperation systems, and parallel computing . It is the largest European research institute, with 1,300 employees at 3 German research campuses, the largest of which is in Sankt Augustin.

The GMD sees itself as a catalyst of innovative ideas in the field of information technology. GMD is a place where researchers can develop innovative ideas in cooperation with partners from trade and industry who transform the obtained research results into new products. GMD's research and development activities are application-oriented and the relevant projects closely collaborate with partners from industry and science. GMD is involved in numerous EU projects: it averages around 70 active EU projects per year. Currently active EU projects include TTN, Advance, DVP, Semper, and eRENA.

GMD is split into several research institutes:

- Institute for Computer Architecture and Software Technology

- Institute for Applied Information Technology
- Institute for Open Communication Systems
- Institute for Media Communication
- Integrated Publication and Information Systems Institute
- Institute for Algorithms and Scientific Computing
- Institute for Autonomous Intelligent Systems
- Institute for Telecooperation Technology

Media Arts Research Studies (MARS), which will be deeply involved with SAFIRA, is an interdisciplinary art and technology research group within the Institute for Media Communication. MARS's research focuses on human presence and experience of new technologies. MARS investigates the aesthetic of interactive experience in the new media environments now integrated into our everyday lives. Our goal is the development of technology that allows for richer human interaction in mediated environments.

MARS is fundamentally concerned with representation and identity in the networked world: how do we perceive ourselves and others on-line? We explore the senses through experimental interfaces and new communication spaces that redefine social interaction in a mediated world. Through interdisciplinary experiments which combine technical innovations with an artistic and playful perspective, we look for new ways of understanding and enhancing human experience of new technology. We believe we need to move away from a science-based understanding of information technology, and turn towards a perception of it that incorporates aesthetics and social aspects. In the center of this change stands communication between people facilitated by their machines.

MARS performs research and development in the fields of social interaction and representation, shared virtual environments, expressive avatar/agent architectures, user interface design, media art and music. Research is based on a unique infrastructure consisting of high end graphics computers, interactive display technology, digital media and interaction devices, virtual studio techniques, broadband networking, and novel, tactile interfaces we build ourselves.

MARS is involved in several collaborations with other institutions. It is involved in the EU i3 eRENA project, which explores interactive virtual environments and interactive TV as engaging performance spaces. With the West Deutsche Rundfunk, MARS coordinates the CYBERSTAR competition, an international competition honoring innovative concepts for audiovisual interactive media. MARS is also a member of the European Consortium of Networked Media Labs, an organization of the major media laboratories in Europe which cooperate in presenting performances of new media systems. MARS can be found on the Web at http://imk.gmd.de/docs/ww/mars/index.mhtml.

10.4.2 Participants

Dr. Phoebe Sengers is a research scientist in the GMD MARS group. Her areas of expertise include believable agents, behaviour-based agent architectures and new forms of avatars. Her work integrates the development of new technology with an awareness of the cultural and social dimensions in which that technology is designed and used. She received a Ph.D. in Artificial Intelligence and Cultural Theory from Carnegie Mellon University, where she worked with Joseph Bates on the Oz Project, pioneers in the development of believable, engaging, social and emotional characters for virtual environments. Her thesis focused on the development of agents which clearly express their emotions and motivations to human audiences. She is currently the recipient of a Fulbright Guest Researcher Fellowship, developing new concepts for avatar-human interaction. She is also involved in the eRENA Project, where she coordinates tasks involving agent and avatar research. She has published in several international conferences, is co-chairing the AAAI Fall Symposium on Narrative Intelligence, and is currently completing her third book chapter.

10.5 Imperial College (IC)

10.5.1 Organisation

As the main expertise of the research group at Imperial College is in the field of Agent Technology and it's applications, their main role in this project will be to contribute in the analysis and design of an enabling technology to support real-time socially intelligent agents with affective behaviour and control. The synthesis of such agents will be implemented through a visual animated Personal Service Assistant demonstrator. Providing as a technology base expertise in the development of multi-agent platforms. They will be involved in all facets of this part of the workplan, including exploration of issues relating to the specification of the framework, high- and low-level design of the proposed toolkit, as well as its implementation providing suitable methodologies and tools.
They will assume the leadership of work-package 2, ensuring that the technical direction of the workpackage is in line with that specified by the project Technical Board and that work is completed in a timely manner. Because of their involvement in the SoNG project (with which this project hopes to collaborate with) they will improve productivity by enabling opportunistic and synergistic transfer between the two projects.
The research group led by Professor Mamdani has considerable research experience contributing in both depth and breadth in designing, developing and deploying Multi-Agent Systems. The Electrical & Electronic Engineering Department has significant research groups on communications and interactive/intelligent systems, which encompasses human-computer interaction and artificial intelligence. Sound working relations exist between the groups that can be exploited to the direct technical benefit of the project. Furthermore, the project would benefit from a symbiotic relationship with several other projects previously and currently being managed within the group. In particular, specific experiences that will help in contributing in the success of the SAFIRA project are:

- KIMSAC (ACTS 030) Design of a basic description language for the integration of multimedia with software agents.
- FACTS (ACTS 300171) Specific contribution has been to the audio visual entertainment and broadcasting application. Major contribution to user modelling and information personalisation. Also, strong experience in the FIPA standards in the human agent interaction part.
- MAPPA (ESPRIT EP28831) Multimedia Access through Personal Persistent Agents for agent visual animation and personalisation to realise some aspects of affective computing.
- CASBAh (EPSERC): This project contributes agent oriented middleware developments providing an agent platform which is FIPA compliant for the development of the software agents for the SAFIRA project.

10.5.2 Participants

Professor Abe Mamdani currently holds the Chair of Telecommunications Strategy and Services (in the Department of Electrical & Electronic Engineering. He is well known for his pioneering research into fuzzy logic, and for his research into artificial intelligence in telecommunications. He has been a leading participant in EU funded research and has been supported since the start of the ESPRIT and RACE programmes. In ESPRIT he participated in successful projects like KRITIC, ARCHON and currently, MAPPA. In Basic Research he was a prime mover in DRUMS and the network of excellence ERUDIT. In RACE and ACTS he played a key role in AIM, GUIDELINE, DESSERT, KIMSAC and FACTS projects. As a leading research worker he has worked for the commission as project evaluator, reviewer, auditor and member of various committees defining themes for future research. Professor Mamdani is a Fellow of the Royal Academy of Engineering and the IEEE.

Yasmine Arafa is a research associate in the Intelligent and Interactive Systems group at Imperial Collage London. Her main research areas are: software agents, affective computing, human-computer interaction, multimedia, e-commerce and data communications. Her current research aims are to integrate social considerations into real-time application interfaces. Yasmine has considerable experience in the field of agent technology and it's applications and development. She has

previously worked on two agent-based research projects: ACTS funded KIMSAC and ESPRIT funded MAPPA.
Yasmine holds an M.Sc. in Data Communications and Distributed Network System from University College London, and a B.Sc. in Computer Science and Electronics.

10.6 OFAI

10.6.1 Organisation

The Austrian Research Institute for Artificial Intelligence (OAIA) was founded in 1984 with support from the Austrian Federal Ministry for Science and Research. Within the framework of the Federal Development Program of the Austrian Government Microelectronics and Information Processing the Institute was assigned key institute for research area S7 Artificial Intelligence. According to this development program, ÖFAI maintains close links to the Department of Medical Cybernetics and Artificial Intelligence of the University of Vienna (IMKAI) as well as to major Austrian companies in industry, banking, and software services. Since its creation, OFAI has been headed by its director, o.Prof.Dr.Robert Trappl.
In fall 1994, the ÖFAI celebrated its 10th anniversary.
At OFAI basic and applied research is performed in several areas of AI, most notably:

- Natural Language Processing
- Neural Networks (Connectionism)
- Machine Learning and Data Mining
- Knowledge-Based Systems
- Constraint Logic Programming
- Intelligent Software Agents and New Media
- AI and Society

OFAI have been closely cooperating in joint projects with many AI research institutes abroad. With respect to the European Union, ÖFAI is a member of several Networks of Excellence: The European Network in Language and Speech (ELSNET), the Network for Computational Logics (COMPULOG-Net), the Network of Excellence in Machine Learning (MLNet), the Network of Excellence in Inductive Logic Programming (ILPnet/ILPnet2), the Network of Excellence for Neural Networks (NEuroNet), and the AgentLink Network of Excellence.
ÖFAI has been partner in many multinational projects including ones sponsored by the EU-programs ESPRIT and Human Capital and Mobility (HCM) and within the Language Engineering (LE) subfield of EU's telematics program. For project details click on the area headings listed above.
The journals "Applied Artificial Intelligence: An International Journal" and "Cybernetics & Systems", both published by Taylor&Francis, have their editor-in-chief and their editorial office based at ÖFAI.

10.6.2 Participants

Dr. **Paolo Petta**, Dipl.-Ing., is the head of Intelligent Software Agents and New Media department of OFAI, a member of, Europe's ESPRIT-funded Network of Excellence for agent-based computing. Dr. Petta main research areas are: software agents, hypermedia, human-computer interaction, affective computing, education. He his co-editor of the Springer´s book “Creating Personalities for Synthetic Actors”.

10.7 Swedish Institute of Computer Science (SICS)

10.7.1 Organisation

The Swedish Institute of Computer Science, SICS, is a non-profit research foundation. SICS mission is to contribute to the competitive strength of Swedish industry by conducting advanced

and focused research in strategic areas of computer science, and actively promoting industrial use of new research ideas and results in industry and society at large. SICS works in a close collaboration with industry and the national and international research community.
SICS's research focus is on distributed and networked interactive real-time multimedia systems and applications -- spanning from infrastructural issues to software methodologies to human-computer interaction. SICS collaborates actively with industrial and academic partners. The core of SICS research is supported by major companies associated with Föreningen för Datateknisk Forskning (FDF), the Swedish National Board for Technical and Industrial Development, NUTEK, and the state-owned Ireco Holding AB supporting industrial research institutes in Sweden. Research contracts assigned by the FDF members and other organizations, Swedish and foreign, speed up dissemination and uptake of research results in industry and public sector. SICS participates also actively in collaborative R&D programs, both national and international, such as Esprit and ACTS funded by the European Commission, and Real World Computing funded by the Japanese government.
SICS has a well developed collaboration pattern with high-tech SMEs in Sweden, carrying our joint projects, and acting as a R&D resource for selected SMEs. SICS has also a proven record of disseminating and promoting industrial deployment of its research findings, including establishing of spin-off companies, as well as licensing of its software and patents. SICS is a member of the following organisations:

- IRIS (Industrial research institutes in Sweden)
- ERCIM (European Research Consortium in Informatics and Mathematics)
- RWCP (Real World Computing Partnership, Japan)
- W3C (WorldWideWeb Consortium)

Some facts about SICS:

- Turn-over 1998: 71 MSEK.
- Staff: In January 1999 SICS had a research staff of 85, thereof 30 PhDs.
- Research Results:
  - approx. 70 refereed papers and articles in international journals and conferences per annum.
  - 2-4 research degrees (doctor and/or licentiate) by SICS employees per annum
  - 1-3 people move to academia for tenured positions (professor, lecturer) per year
- Industrial results: on average
  - 10 people per year move to the industry
  - 1-2 SICS projects and patents are transferred to the industry
  - 1-2 spin-off companies are formed
  - distribution of software is responsible for approx. 5% of the turn-over.

SICS's research is distributed among several groups**:**

- Real-time Computer and Networks Architectures
- Computer and Network Architectures
- Software Methodology for Distributed Systems
- Formal Design Methods
- Intelligent Systems Laboratory
- Neural Networks and Real-time Computing
- Human Computer Interaction and Language Engineering
- Interactive Collaborative Environments

The SICS participants in Safira come from the HUMLE laboratory, which is part of the Intelligent Systems Laboratory. The HUMLE laboratory focuses on novel types of support for information management. The research is mainly motivated by the ongoing increase in ubiquitous access to masses of uncoordinated services. The laboratory encompasses three groups, the Information and Language Engineering Group (ILE), the Individuals in Space group, and the Open and Adaptive Service Infrastructure (OASIS) group. The research groups in the HUMLE share a common

perspective which can be described by three basic beliefs: the importance of human language, the trust in the human user, and the support for tailorability and adaptivity, rather than developing large, generic solutions. In all of our projects, we place an equal focus on human-centered design and evaluation, as on the technical development. HUMLE is one of the few research groups around the world that has done research in the area of development of methodology for designing and evaluating intelligent and self-adaptive interfaces.
Some examples of previous HUMLE research results include:

- A natural language interface for virtual environments (the DILEMMA project). In this project, we evaluated the effects on language interaction of different types of tools for language feedback.
- The user and communication models for the CommonKADS development method for expert systems (within the KADS-II project, EU Esprit programme), including a cyclic model for design and evaluation.
- An english to swedish spoken translation system (the SLT project run in collaboration with Telia Research and SRI Cambridge).
- A web-based adaptive information system providing information on a development method (the PUSH project, run in collaboration with Ellemtel).
- A design methodology for spoken interaction with phone-based services (the DISA project, run in collaboration with Telia Research)
- Agneta and Frida: a character-enriched web browsing demonstrator (within the PERSONA project, EU I3 programme, proactive research), evaluated with partly new and innovative techniques.
- An edited, adaptive web-based information service for calls to conferences (within the EdInfo project)
- sicsDAIS: an interaction system enabling integrated interaction with multiple services (within two projects: the KIMSAC project within the EU Acts programme, and the IntAge project funded by KFB, the Swedish board of transportation)
- an adaptive information service for music with both web-based and phone-based interaction (in collaboration with a small company Pipebeach)

More information about the HUMLE research group, projects and publications can be found at http://www.sics.se/humle.

10.7.2 Participants

Kristina Höök is the laboratory manager of the HUMLE laboratory at SICS, Swedish Institute of Computer Science, Kista, Sweden. She holds a Ph.D. and a Ph.Lic. in Computer and Systems Sciences at Stockholm University, and a M.Sc. in Computer Science at Uppsala University. Kristina has worked in several sub-fields of human-computer interaction, including intelligent user interfaces, affective interfaces, individual differences, and user interfaces for all, and she has taken part in exploring and establishing the research field of social navigation. Her approach has been a combination of design ideas, system implementation, and user evaluation studies. Kristina has published around 20 scientific papers, edited a book published by Springer together with A. Munro and D. Benyon, given a tutorial at several international conferences, coordinated one EU-project within the i3-programme, and managed about 10 research projects amounting to over 20 MSEK. Kristina was awarded the Cor Bayeen fellowship in 1997 for her thesis work. Kristina serves on the extended adjunct committee for ACM SIGCHI, the board of the Centre for Information Technology and Cognitive Sciences at Stockholm university / KTH, and numerous program committees including AH'01, IUI'00, UM'99, WebNet'98.

Kristina currently manages the HUMLE laboratory at SICS, an interdisciplinary laboratory consisting of around 20 employees with backgrounds in computer science, human-computer interaction, computational linguistics, psychology, film studies, and library science. The HUMLE

laboratory develops new techniques and design metaphors to make the interaction between human and computer richer, more fun, social, and better adapted to human beings. The focus is on social computing, mobile scenarios, individual differences, and language engineering.

Annika Wærn, PhD 1996, Ph. Lic. 1992, currently employed at the Swedish Institute of Computer Science as lab leader for the Human Computer Interaction and Language Engineering (HUMLE) lab. She has previously done research on analysis and compilation of parallel logic programming [Winsborough and Waern 1988]. She moved over to the area of intelligent interfaces in approximately 1990. Her Ph.D. thesis concerned the theory and practice of reactive plan recognition. She has been responsible for the HUMLE involvement in two EU projects, the KADS-II project and the Kimsac project. Her current research interests focus on the development of tools and techniques for supporting humans interacting in Open Service Environments, in particular on human-supported information filtering services [Waern et al. 1998] and interfaces to open service architectures [Espinoza 1998].

10.8 Some Relevant Project-Related References by Consortium Members

André, Elisabeth (ed.). Animated Interface Agents: Making them Intelligent. Vol. 13, No: 4-5. 1999.

André, Elisabeth and Thomas Rist (eds.). Intelligente Informationsagenten. KI Zeitschrift,.Vol. 3. 1998.

Andre, E., Brooks, K., Nack, F. Petta, P. Stenmetz A. (eds): AI/Alife and Entretainment, Workshop Notes of the ECAI-98 Workshop, Brigton, UK, August, 1998

Arafa, Y.; Charlton, P.; and Mamdani, A "Modelling personal service assistants with personality: from metaphor to Implementation*, Proceedings of the Workshop on Grounding Emotions in Adaptive Systems*, International Conference on Simulation of Adaptive Systems (SAB98) 1998.

Botelho, L.M. and Coelho, H "Artificial agents with artificial emotions" International Conference on Autonomous Agents (AA'98), ACM Press, 1998.

Botelho, L.M. and Coelho H. "Emotion based attention shift in Autonomous Agents" in Muller, J.P., Wooldridge, M. & Jennings, N. (eds) Intelligent Agents III: Agent Thories, Architectures and Languages" (ATAL-96), 1996.

Martinho, C. & Paiva, A. "Emotions for a motion: Rapid development of believable pathematic agents in intelligent virtual environments", to appear in the Applied Artificial Intelligence Journal, 1999.

Martinho, C. & Paiva, A. "Pathematic Agents", in the Proceedings of the Autonomous Agents Conference´99, ACM press. 1999.

Paiva, A. & Machado, I. - Vincent an autonomous pedagogical agent for on-the-job training, in the *Intelligent Tutoring Systems*, Ed. V. Shute, Pub. Springer-Verlag, 1998

Paiva A. and Self J. :"TAGUS- A User and Learner Modeling Workbench" in International Journal of User Modeling and User-Adapted Interaction", Kluwer Academic Publishers, 4(3), pp. 197-226, 1995.

Petta, P. Trappl, R.: Personalities for Synthetic Actors, in Trappl R. & Petta, P. (eds) Creating Personalities for Synthetic Actors, Springer, LNAI 1195, 1997.

Petta P.: Principled Generation of Expressive Behaviour in an Interactive Exhibit, in Velasquez J. (ed.) "Workshop on Emotion-Based Agent Architectures (EBAA'99), in AA'99. Seattle, USA, 1999.

Sengers, Phoebe. Designing Comprehensible Agents. Sixteenth International Joint Conference on Artificial Intelligence. To appear, 1999.

Sengers, Phoebe. Do The Thing Right: An Architecture for Action Expression. Proceedings of the Second International Conference on Autonomous Agents. May, 1998. 24-31.

Sengers, Phoebe. Narrative Intelligence. In *Human Cognition and Social Agent Technology*. Ed. Kerstin Dautenhahn. John Benjamins Publishing Company. Forthcoming, 1999.

Trappl, R. & Petta, P. (eds) Creating Personalities for Synthetic Actors, Springer, LNAI 1195, 1997.