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Virtual Puppets in Performance

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"Already something like digital avatars exist for virtual immersion arcade games and for players on video game networks. It is only a matter of time before some enterprising puppeteer converts one for use in a theatrical performance." (Kaplin 1994)

Characters inhabiting the various digital "stages" from computer games to online virtual worlds already have popular names such as Avatars, NPC's (Non Player Characters), Bots and autonomous agents. "Virtual puppets" is a new term adapted in this context in an attempt to relate the theory and praxis of traditional puppet theatre to the possibilities of the computer medium. After a brief introduction to the concept of virtual puppets, this paper will give an account of an artistic experiment where virtual puppets were tried out in a rather traditional form – as theatrical puppets in a stage play.

Virtual puppets

"Virtual puppet" is a term coined by puppeteer Stephen Kaplin, which includes puppets in contemporary media in an overall model of puppets throughout history (Kaplin 1994). The concept of virtual puppets challenges the traditional understanding of the puppet because of its special materiality. It is made of light on a screen, which is dependent on the mechanics and the visual display methods developed by designers, engineers, and computer scientists. In modern puppet theatre and performance though, it is more a question of seeing this special materiality as a new exciting phenomenon and a way to develop contemporary puppets for the performing arts.

Virtual puppets fall into a category of what Steve Tillis calls "media figures" amongst other mediated puppets such as filmed puppet animation, which are "figures whose performance is made possible through technological mediation" (Tillis 1999 pp. 182). Understanding what virtual puppets are and how they differ from traditional puppets can, according to Tillis, be described by looking at how they are created and controlled. The materiality of the virtual object we know from computer monitors and video projections, but the tangible movement of it in real time through a steering device is something conceptually new. Steering devices can vary from simple keyboards or joysticks to advanced optic or magnetic "Motion Capture" equipment. Motion Capture is a computer based technique to register and record the detailed movement of a performer, which can then be mapped onto a 3D animation and other computer based media. These techniques have been used widely for special effects in films such as "Terminator II" and the 3D animated film "Toy Story".

"Performance animation" is a new type of animation where motion capture data is used to generate computer animation in "real time". This means that the performer can get direct feedback and thus see the end result, or some representation of it, on a monitor when performing. If the animations are projected onto the stage in a live performance it can be seen as a new type of puppetry, since the performer is "playing the animation" on stage for an audience. Since all the data from the devices has to run through a computer then automatization, computer manipulation, and long distance transmission are all possible features of the virtual puppet.

Autonomous agents in research

To understand the complexity of the concept of virtual puppets one will have to look more closely at the research within computer science and electronic engineering.
The study of "Autonomous Agents" has become an academic research discipline concerned with the development of computer generated characters which can inhabit the virtual world of the computer and as the name suggests can have its own "free will". Large interdisciplinary research projects have been set up to develop these characters for different purposes; the construction of industrial robots, helpers in computer programmes, educational programmes, entertainment and so on.

Informed by a broad variety of traditional research disciplines spanning from cybernetics to dramatic arts and 3D modelling, researchers try to create formal models and algorithms that can generate their appearance and their actions.

Projects inspired by dramatic arts often set as their research goal the creation of agents that speak and act in a way that is "believable and personality rich". Various definitions for Autonomous Agents and their features from this angle can be found in a report on the American research field by Michael Mateas:

"A believable character is one who seems lifelike, whose actions make sense, who allows you to suspend disbelief."
(Mateas 1997)

The focus here is mainly on the possibility of building and representing the character in a fictional universe, which indicates that the computer medium is at a very early stage comparable to the infancy of film. The distinction between real and virtual objects implies that real objects are "any objects that have an actual objective existence" whereas virtual objects "are objects that exist in essence or affect, but not formally or actually", meaning that virtual objects can only be experienced through a medium:

"In order for a virtual object to be viewed, it must be simulated, since in essence it does not exist. This entails use of some sort of a description, or model of the object" (Milgram and Kishino 1994)

In the academic research community, where artistic production experience is limited and of second priority, projects often end up with very complex models for the characters. These models are necessary since they are the mechanics driving the characters' speech, actions, movements etc., but they still leave the actual "physical experience" of the character to our imagination. Normally an agent's architecture consists of a model for how the agent perceives the world and how the agent reacts to the world according to this received world:

"An agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through effectors."
(Russell and Norvig 1994)

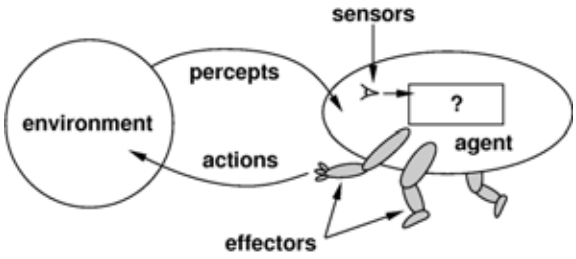

Figure 1 *AIMA (Artificial Intelligence – a Modern Approach) a simple model for an agent. (Russell and Norvig 1994)*

Dependent on the complexity of the models, the agents can have varying "intelligence", informed by research in artificial intelligence. Selmer Bringsjord for example suggests the use of knowledge databases combined with logic rules analyzing and selecting appropriate "dramatically compelling" actions for a given situation. (Bringsjord 2001)

Another interesting approach is to create models determining the "mood" of the agent, as in the "finite state automaton" for the agent "Bouncy". This automaton contains the following states "play, tease, please, sleep, have the blues" and rules for how to go from one state to the next. (Madsen & Granum 2001 pp. 186)

When the physical appearance of such an agent is in question associations with the automatons of the mechanical theatre are obvious. Tillis describes the movement possibilities of the automaton as "closed" since all the movements are invariable; even if they are altered they would "only have a new invariable programme" and can be "considered as kind of a kinetic sculpture". (Tillis 1999 pp. 193) The presence of a puppeteer gives the puppet, no matter how simple it is, "open" movement possibilities. With the introduction of advanced technology new types of puppets appear which seem to be somewhere in-between these extremes.

The animatronic is a puppet normally used in puppet animation films and for special effects in feature films. It can be controlled by very advanced often computerised steering mechanisms "obscuring their control mechanics and in attaining an exceptional degree of verisimilitude – they generally do not look like puppets" (Tillis 1999 pp. 192), which transcends the clear player-character relation of the traditional puppet. Conceptually it is still a tangible puppet, tangibly controlled, but the advanced features, such as naturalistic motion capture control, change its aesthetic and make it a very distinct type of puppet. This is mainly because the "dualism of the puppet", described by Jette Lund in her presentation, "Computers and puppets" at this symposium, is removed through mechanics. (See also Lund 1995)

From the perspective of agent research a central goal is finding methods of obscuring the control mechanics of the agent for the spectator. This actually succeeds in some cases, but then it is often a simulation of real life phenomenon, which is the focus in the research field of Artificial Life. Convincing behaviour patterns can emerge from a set of simple rules such as the flocking of birds or the swarm of flies programmed by Keith Wiley, but this a long way from articulating theatrical actions.

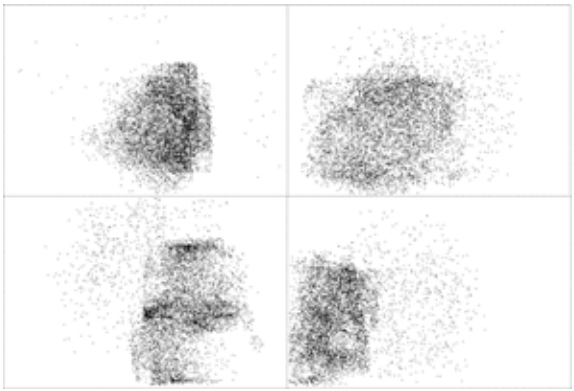

Figure 2 *Emergent movement patterns amongst artificial flies. (Wiley 1997)*

From the perspective of the theatre this can be seen in relation to Oscar Schlemmers pretension "to reach the organic through a maximum of mechanisation". (Kirchmann 1997 – Own translation) A step that in my opinion can not be made exclusively with models from natural science - it must also involve interdisciplinary elements such as the application of scientific rules to aesthetics, which was the aim and method of Schlemmer. His way of describing the relation between the audience and the performer through simple rules for example gives an understanding of how theatre becomes a convention in real life.

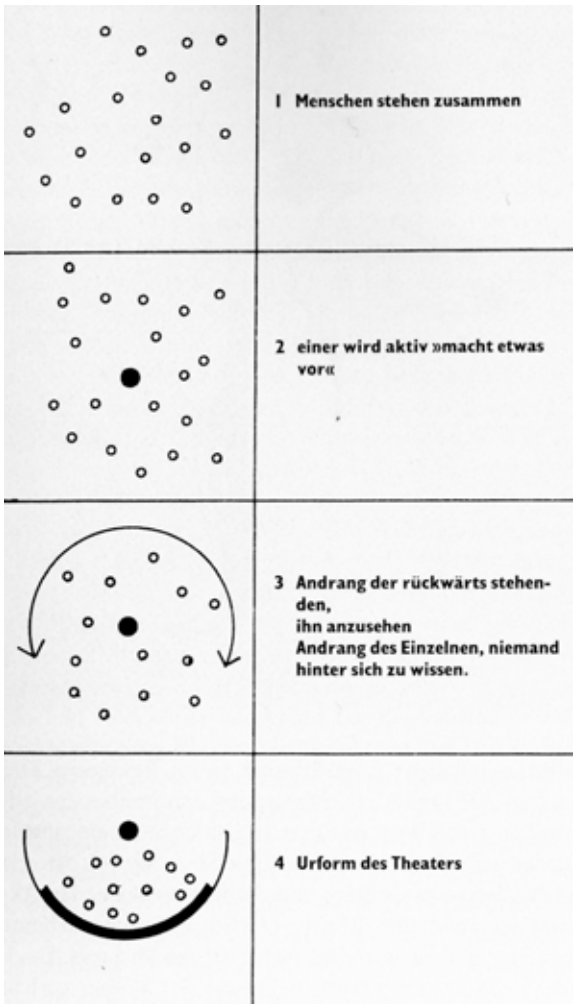

Figure 3 *Theatre scenes (excerpt) - Schematic drawings from Schlemmers teaching material 1928.*
1) People stand together 2) one is "making an act" 3) (People) rush from the back (to the front) to see him. Rush of individuals knowing not to have anyone behind him 4) the archetype of the theatre (Own translation) (Scheper 1988)

Virtual puppets in computer games

Living examples of virtual puppets are actually often found outside scientific research and the performing arts – namely in the colourful world of the game developers. The games industry has spawned myriads of new creatures based on similar ideas, but often simpler principles – driven by an intuitive instinct of what will sell and appeal to a broad audience for entertainment and leisure.
Large budgets and professional production environments have made this area so advanced that it has become one of the greatest sources of developing technology, tools and artistic skills to create inhabited virtual worlds for entertainment and commercial purposes. Here we find heroines like Lara Croft, monsters, mutants and soldiers, automated family members and pets.

These characters have simple designs and crude movements compared to animated film and the puppet theatre because real time animation on home computers puts strong restrictions on the level of detail in the animation. Furthermore they are normally controlled through simple devices such as joysticks or keyboards, but even so they have similar features and functions as other puppets as pointed out by Jette Lund. (Lund 2001)

The materiality of the virtual puppet

The notion of the virtual puppet is based on assumptions about the materiality of the virtual character and the relation between the virtual character and the person or "entity" that is playing it. If one perceives virtual worlds as a hybrid between a filmic and a theatrical space the materiality can be described in relation to traditional media. This is inspired by a phenomenological analysis of the impression of reality in film and theatre by French film theorist Christian Metz:

"Because the theatre is too real, theatrical fictions yield only a weak impression of reality. Conversely, according to Jean Lairens, the impression of reality we get from a film does not depend at all on the strong presence of an actor, rather on the low degree of existence possessed by those ghostly creatures moving on the screen and they are, therefore, unable to resist our constant impulse to invest them with the "reality" of fiction, a reality that comes only from within us, from the projections and identifications which are mixed in with our perception to the film."
(Metz 1974)

Virtual puppets share some characteristics with characters in the animated film – they are intangible and exist as light on a screen. The fascination with animated film has been described by O'Pray as a "protoplasmic quality" since it gives the spectator the awareness that it "contains all possibilities of future species and forms" (Wright 1995 p. 52) At the same time the aesthetics of 3D animation have a distinct "3D look" concerning textures, polygon count and level of detail determined by the particular 3D engine generating it. Everything is made out of the same material in a virtual 3D animated world, so if the materiality of the characters and objects have to make sense in relation to the spectators experiences from the physical world, it has to be emphasised in the design and in the way it is played.

In the film "Toy story" Buzz Lightyear and Woody are meant to be made out of different material in the 3D computer animation – plastic and Wood. The only way the audience can know this is through Woody's name. Visibly the different textures on the character design look like plastic – and their intended plastic and wooden look of the bodies have only a minor effect on how they move or behave in the film.

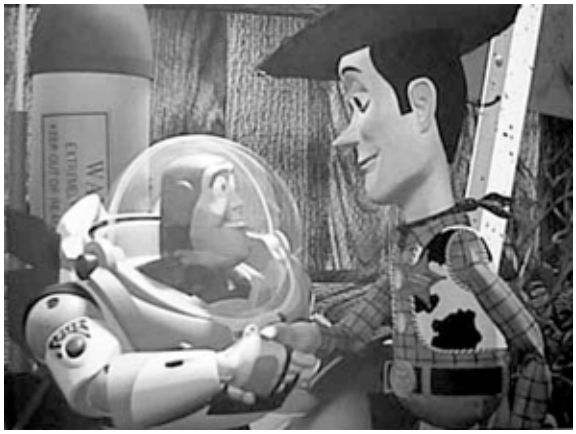

Figure 4 *Buzz Lightyear and Woody from the film "Toy Story" (c) Disney/Pixar, 1995*

When we take a look at the soldiers in the same film we see that their materiality is taken account of – they are made out of plastic, their feet are stuck to a stand and they cannot move unless someone moves them. But in the story they have learnt to move by themselves. In spite of their handicap they stumble along and do all the things soldiers do; and here the magic begins!

Figure 5 *Soldiers from the film "Toy Story" (c) Disney/Pixar, 1995*

The player-character relation: Who is playing, who is acting?

Since we are able to act "physically" in the virtual world through different steering devices, we also have the deictic presence of the actor known from the theatre. We are in the centre of action; we can make the characters jump and run, smash things up and kill other characters and even one's own character! Seen in this light the relation between the person steering a virtual character and the puppeteer playing a physical puppet becomes obvious. The special fascination with interaction in virtual worlds is thus similar to the duality of the puppet theatre described by Jette Lund: "it seems real, but it is not real". (Op. cit.)

In this approach to virtual puppets, which differs from most research into autonomous agents and artificial life, the focus is on articulating this duality rather than obscuring it. If it is true that the duality of the puppet is the "specific of the puppet play" and its "smallest unit" as stated by Kavrakova Lorenz (Lund op. cit.) then the spectator will always intuitively be aware of the "engine" behind the virtual puppet - be it a person or a computer programme - which must then be seen as a vital part of the dramaturgical construction.

Instead of copying nature the focus must be on modelling theatrical acts and conventions, developing "Agents as actors". (Andersen & Callesen 2001)

In this light the virtual puppet provides us with some interesting new ways to articulate the player-character role in experimental theatre. An example of the avatars being more than just a doll for playing with comes from an international experiment from 1998, where the aim was to produce Shakespeare's "A Midsummer Nights Dream" for a performance in a virtual world on the internet. The characters were played by puppeteers and the voices transmitted live. The audience could walk freely around on the stage during the performance since they were represented by an "invisible camera" controlled by a joystick. As a special feature they could even take the point of view of any of the characters in the play. (Coco 1998)

The play has to my knowledge not been recognised by the theatre world, probably because of the poor expressive possibilities of the puppets and the problematic dramaturgical consequences of the partaking audience - which are elements that have to be developed to a point of excellence for it to succeed. But nevertheless the idea is new and the ability to experience with your own eyes what it is like to be under the influence of Puck's love potion is intriguing.

This experiment in "on-line theatre" can be seen as an early exponent for an interest in entertainment and cultural activity in the emerging online worlds. The following example of participating audiences is from the on-line game "Everquest" where people initially meet to play a game, but actually all sorts of social activity takes place there.

Figure 6 *The gathering of several avatars and Non Player Characters in the world of "Everquest" described by its creators as "a real 3-D massively multi-player fantasy role-playing game".*

The various possible character/player combinations can also be explained by focussing on the psychological relations between them, which is relevant to the theatre.

1) The avatar becomes a playing doll, representing your own psychology and abilities. Game designers are well aware of this – if the personality of the character becomes too complex you cannot give it your own personal traits.

2) The avatar of other persons becomes a playing doll with the ability to play "the joker" – is it *really* another persons avatar or is it an agent controlled by the computer (as in example 3) - or is it in fact played by a puppeteer? (as in example 4)

3) The autonomous agent becomes a "virtual automaton" which is designed to perform an act for you. The psychology of this character is what the designer and author try to express.

4) If the avatar was played by a skilful puppeteer it would have the psychology of the theatrical puppet, drawing on conventions which the spectators will have to know or to learn.

Introducing the notion of the virtual puppet presents us with the question of the aesthetic and metaphysical consequences of formalising inner traits such as models of consciousness, language, and models of emotional patterns – and even the theatrical act itself - which goes far beyond that of the mechanical theatre. This is seen in practice when researchers and game designers develop autonomous agents, they face the same challenge as the puppet maker and the puppeteer, which is finding a material form which can represent the inner life of the character though theatrical actions.

On the other hand the different types of identification with the virtual puppets and the various relations between them create a lot of possibilities, which are new to the theatre. What is not new to the theatre and in particular the puppet theatre - is the ability to articulate these possibilities in theatrical actions – and the knowledge that the representation of life goes beyond exact scientific and naturalistic models – the very topic of this symposium.

This inspired me to carry out a theatrical experiment with virtual puppets – first of all to produce a play in its own right and secondly develop the thesis that computer generated agents can be compared with physical puppets in many aspects. The motivation behind the project was to tell the story about "the family factory" and curiosity about virtual puppets in performance:

What can they bring to the theatre? And what kind of theatre will it be if they were brought there?

The family factory – an artistic experiment with drama and performance animation

The goal with the experiment was to bring virtual puppets on stage to investigate and develop them as theatrical puppets for the play "The Family Factory".

The participants in the project came from an interdisciplinary background within animation, puppet theatre, computer science, and media production. Initially it was a joint collaboration between Aarhus University multimedia dept., the theatre school "Ernst Bush" Berlin dept. of puppet theatre, and the national Danish Film School dept. of Animation.

Originally, I wanted to use both virtual puppets controlled by puppeteers and autonomous virtual puppets generated by a computer programme but this was soon rejected, since designing and integrating the virtual puppets in the play in itself was a difficult task. It very soon became clear that what seems banal in the context of computer science can be very complex in another – and vice versa.

The story

The story is inspired by fairy tales, short animated films and British social realism (Mike Leigh and Ken Loach). It is about a little girl who on a magic day sees the alter egos of her family members and herself - as a representation of what they really feel and think – behind the facade of the everyday routine. The alter egos were going to be played by virtual puppets projected into the wallpaper in their council flat.

The appearance of the puppets eventually frightens the little girl and makes her confront the other family members, big sister, father and mother with what she sees. Unfortunately the confrontation only creates chaos and terror – which she then tries to bring back to order by pretending they are not there – just like the others.

Designing the puppets

The character design for the four family members was done in collaboration between the puppeteers and the animators and refined throughout the period. I wanted the puppets to be expressive, humorous and different from the detailed, naturalistic and polished look of much 3D animation. I also wanted the simplicity of real time animated characters from computer games, an abstract contorted style in representing the psychology of the characters and finally a "paper like" quality in the textures.

All the puppets had individual symbolic attributes;

Father the big hand
– his false authority

Mother her hair
– emotion and aggression

Big sister hands and feet like knives
- power and ambition

Little sister big eyes and pockets
– openness, curiosity, truth

Figure 7 *The virtual alter egos of the family members.*

In the process of devising the story of the little girl and her impossible family different acting techniques and features for the virtual puppets were invented and tried out. The mechanics of the puppets were developed with the aid of a programmer until a point where their final functions were determined. I did not want to create a new type of virtual animatronic since the content of the play is based on the duality of the puppet. It was very important that there was a clear relation between the puppet and the performer playing it. In the following description of the virtual puppets the terminology proposed by Steve Tillis is used. (Tillis 1999)

The real time animation software used, Filmbox by Kaydara, is mainly developed for a naturalistic one-to-one "physiognomic analogue" between the performer and the animated character. In this approach to performance animation a number of magnetic sensors on the performer's body relates to the same parts of the animated character. The Filmbox has a built-in virtual skeleton onto which the animated character can be attached. The skeleton is controlled by an "inverse kinematics system" meaning that the movement of a single body part will spread to the attached parts. In this way the whole skeleton can be controlled in a naturalistic way by only a few sensors. The software supplies a representation of both the actor and the character in the "virtual environment" combined with a programming platform. This gives good opportunities for the development of creative and dynamic mapping techniques other than the naturalistic "physiognomic analogue".

In our approach we used a one-to-another relationship where individual sensors controlled different parts of the puppet in various "movement analogues". The artistic challenge lies in articulating the relation between the physical actor and the animation in the projection. The control techniques developed for the puppets used a combination of "gesture" and "proxemic" movement of the puppet, which ended up being both filmic editing techniques and puppet animation techniques.

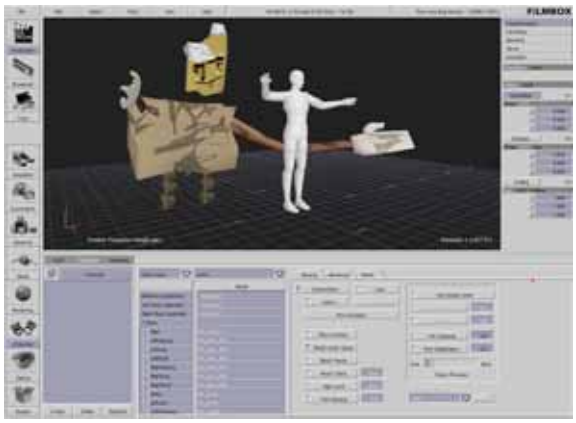

Figure 8 *The Filmbox supplies both a representation of the performer and the virtual puppet he is animating.*

The proxemic movement, which concerns moving the puppet in space, had to be approached in a special way since the character had to "come out of the wallpaper". This was done by developing a zoom technique, where the movement of a magnetic sensor back and forth on stage meant that a puppet was gradually scaled from small to large. The movement across stage was thus a "pan" effect created by moving a sensor from side to side. Another technique developed was the "cut" from total to close up, which was done by turning a sensor 90 degrees as a kind of switch.

The gesture movement was a combination of the naturalistic movement of the built-in virtual skeleton and the stylised movement of the body parts of the virtual puppets to which the sensors were attached. The stylised movement is comparable to the techniques demonstrated in the workshop by Michael and Michaela Meschke focussing on rotation and inclination.

Finally there were the individual attributes of the characters which had to be specially modelled - for example the hair of the mother. To gain sufficient control a four-joint skeleton was inserted into each strand of hair. One handheld sensor was controlling the rotation and inclination of the head to which the straws of hair were attached. Another sensor attached to the foot of the actor would control to what degree the hair would be spread out. By combining the two controlling devices a lot of dramatic effects could be created with the hair.

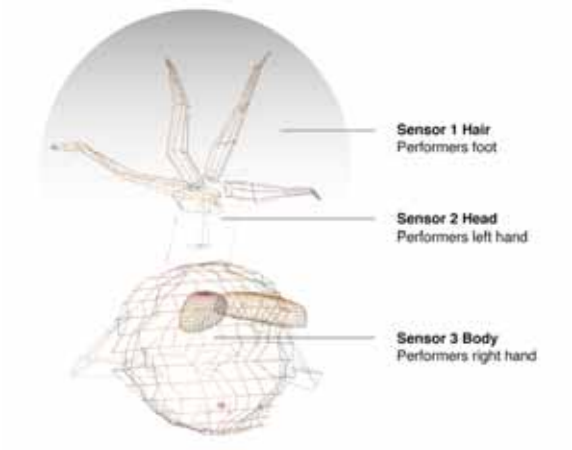

Figure 9 *The Mother's puppet was controlled by 3 sensors:*
Sensor 1 was attached to the foot of the performer spreading the strands of hair when turned from 0 – 45 degrees.
Sensor 2 was inside a toy and held in the performer's left hand – it controlled rotation and inclination of the head.
Sensor 3 was inside a toy in the performer's right hand – moving the puppet in space through the zoom and the pan function.

Levels of representation

In most virtual reality research and production the goal is to optimise the representation of a "parallel reality" with reference to an objective reality we all share, which is very often a naturalistic model of real life. Terms such as mixed reality, augmented reality, and augmented virtuality are used by VR researchers to give a nuanced description of the used display methods in the continuum between the real environment and the virtual environment. (Milegram and Kishino 1994)

In the play however the representation concerns the creation of conventions from animation and puppet theatre to establish the fictional universe and the psychology of the characters. The story being quite simple, the psychology of the characters was developed on stage by representing different levels of "mixed reality" through a variety of media and the relations between them.

In the play each of the four characters has five "lives" or five levels of consciousness through which they navigate. The family members are not in contact with their feelings. They are only aware of one level at a time or not aware at all – except for little sister, who has not yet "learnt" to separate or to suppress them.

Figure 10 *Morning scene – the perfect couple ready to go to work.*

1. level

The council flat: morning – afternoon – evening. What actually happens – stylised absurd style of acting.

Figure 11 *Big sister is cynically giving details about a pupil who had a dangerous accident at the School of Ice Dance, where she is in the elite.*

2. level

Flashbacks: The characters' are telling their own stories about what happened that particular day. The story is heard by the others but nobody is "listening". The acting style is realistic. The animated alter egos show themselves on the screens but can only be seen by little sister.

Figure 12 *Big sister is confronted with her cold ambition and cynicism.*

3. level

The breach: the characters are transformed to their alter egos carrying masks. Their subconscious is materialised.

Figure 13 *Mothers dream of the applauding family after performing as a celebrated singer in the Jazz club.*

4. level

The dreams of the characters: filmed images keyed into an animated background.

Figure 14 *The alter ego of little sister flying over "Suburbia"*

5. level
Back to the point of departure: the alter ego of little sister is vanishing out of the window.

Figure 15 *Father is talking about work whilst playing with little sister and her toys.*

X. level
The toys of little sister: the toys are used to integrate the sensors on stage as a natural part of the family life. But they also tell a story, since they wander from hand to hand during the day and had to be destroyed to establish order in the family life. The relation between the toys and the virtual puppets is interesting and could have had a more significant meaning in the play, which is why it is called the "x-level".

Everyday life is a routine in a world where people don't notice one another, where emotion is replaced by convention. The working life is just as conventionalised, where conflict and frustration is never admitted or reflected.
The family life is described as stylised and absurd (level 1), whereas the stories from work and school are told in flashbacks and in a more realistic playing style (level 2). The silence and blindness, which is the result of the disguised emotions, is exhibited through the animated characters on the wallpaper. They show that the characters are split up. When this common convention is broken by little sister the facades break and the real faces show through their masks (level 3). When the family breaks down, under the pressure of facing another aspect of reality, they cling onto their unfulfilled dreams – of what they always wanted (level 4).

The key, which combines these levels of consciousness are the toys of little sister. When they are thrown away her magic ability to "see" disappears and the virtual puppets vanish (level 5).

After which family life can be re-established.

Conclusion

The experience of the experiment gives an understanding of the ability and aesthetic potential of virtual puppets and points in different directions.

1) The possibilities and restrictions of virtual puppets in contemporary theatre/puppet theatre.

2) A new perspective within the research of autonomous agents and interactive storytelling.

3) The development of performance animation as a new art form, which is a hybrid between puppet theatre, animation, media production and computer science.

Bridges between art and technology can be built through interdisciplinary projects - especially if they are developed step by step in theory and practiced in an open and constructive dialogue between the established traditions.

This approach is not new at all – some of the most fruitful experiments in modern experimental theatre have been created this way.

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