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Aesthetic Cybernetics – Turning towards Senses of Man and Machine*

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Abstract - *Experiences from simulation studies of industrial control systems and performing art oriented human-machine installation suggest how cybernetics may benefit from art and vice versa. We argue for a constructive and analytic multi-focus on Control and Communication in the Animal and the Machine aiming at a close integration of art, science and technology. An industrial simulation project for the design of a new Container Terminal (harbour-logistics) and four public performances demonstrating human/machine interaction are presented: Theater of Machines, Sensory Garden and others. Possible impacts for systems design and mechatronics education are discussed.*

Keywords: Human-Computer-Interaction, Aesthetic Computing, Simulation, Mixed Reality, Performing Art.

1 Introduction

Aesthetic Computing [2], [13], [14] is a new growing approach to merge art and computer science, aiming at a fruitful synthesis of two perspectives: applying aesthetics to computing and applying computing to aesthetics, striking a balance between cognitive and material aesthetics. With a special focus on control theory and sensor/actuator integration, we try to extend this approach to *Aesthetic Cybernetics*.

The Art and Science of Mechanics, Automata and Computer Technology has a long tradition in performing arts, rooting back to the ancient Greeks. Theatre has always been influenced by imaginations of constructed humans and "born" artificial objects, like puppets or surprising mechanisms, deus ex machina. However, it has only been recently, that Computer Scientists recognised, that there may be interesting perspectives from performing art to inspire human-computer interaction solutions [15], [16], [19], [24].

In a former research project [8] we investigated possibilities and restrictions to use simulation technology for the design of industrial systems from a participatory perspective. During a simulation process to support the design of a new container bridge (crane-system) and its operating, we appreciated the participation of an artist having a different view on formal processes. This view inspired the design team to think beyond system boundaries and normal operating of the system, thus contributing to a better anticipation of future work situations. On the other hand, we moderated student-projects at Bremen University, with participants from *Informatics, Digital Media* and *Culture-Sciences,* leading to performances with a strong focus on human-computer interaction. Our experiences will be presented and reflections undertaken, how they could influence systems design and further education in human-computer interaction and cybernetics.

2 Industrial Simulation

Important components of a container terminal are bridges (cranes) to load and unload the container ship. The structure of these bridges and their mixed operating by humans and automata has a major influence on their throughput. Before building these large constructions it is desirable to simulate the dynamic behaviour of the system and evaluate the required rules for a safe operation. In an interdisciplinary design and simulation team, several alternative constructions (type of land vehicle: VanCarrier, Automated Guided Vehicle or Truck, and structure of the bridge: number and size of horizontal and vertical layers) had to be evaluated from a performance, safety, ergonomic and social point of view. Variations of solutions and their interpretations have been inspired by the presence of an artist and his tendency for joyful play.

A typical example, we also found in other simulation studies, followed the pattern of non-logic. Asked to discuss the synchronisation rules between the uppermost cat (crane), the lower cat, the VanCarrier and the ground-persons checking the container, the technical design team used formal methods, like Petri-nets, to describe the behaviour, articulated a behaviour by gestures and the movement of concrete every-day surrounding objects. The artist used some irrational word games like "the cat is grasping between the legs of the VanCarrier, takes the container and then kicks away the driver." We had the impression, that these irrational fantasies contributed to

some increased flexibility of how we thought about the system. It was the introduction of rich dream-thoughts into the reduced process of linear logic.

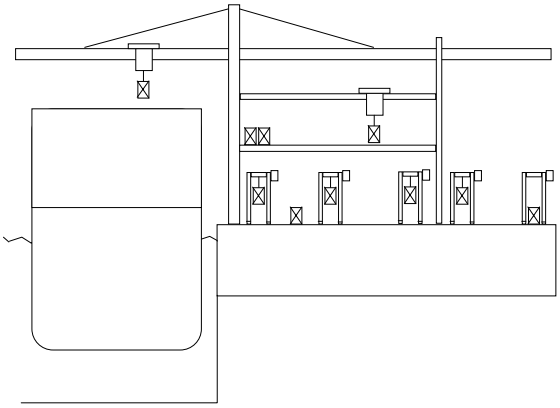

Figure 1. Container-Bridge in a simulation

had to undertake intensive work to develop the control algorithms and the graphical user interfaces to be able to act and react in a sensible way on the course of the play.

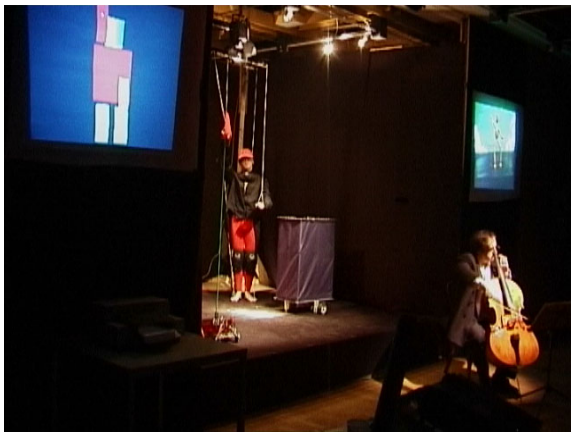

Figure 2. Theatre of the Machines: A struggle between Man, Machines and Nature

3 Performances

3.1 Theatre of Machines

Two robots, a human robot player, a symphonic cellist, an avatar, a wooden marionette on a stage elucidated the problem of control in the man-machine-system. The cellist artist played with great intuition and sensuousness some classical music in front of the stage, during which time an avatar, being projected on the wall started to move to this music, controlling at the same time a real puppet, hanging in an implemented actor mechanism. As soon as they started to develop an independent behaviour, the cellist was asked by some superior ghost to take over the control of the marionette and the avatar. The cellist thus moved into some gallows-device (Figure 4), where he could use several strings connected to his arms and limbs to control the marionette and the avatar by a sensory mechanism. While he was trying to control the machinery, it could also be interpreted as if he was just another living marionette controlled by the programmers behind the curtain in charge of the whole installation. A human robot player then tried to take over the cello of the musician who opposed him and it came to a struggle between the robot player, two robots and the cellist with an open end left to the fantasy of the spectators.

The installation was run on a LAN of three computers, responsible for visualization of the avatar, control of the marionette, sensing of the gallows and sound/music generation, interactively driven by some students behind the curtain. The performance was presented at the 2nd International Theatre Meeting Stuttgart 2000 [1].

From a spectators point of view the control mechanism in the scenario was not obvious. The performing students

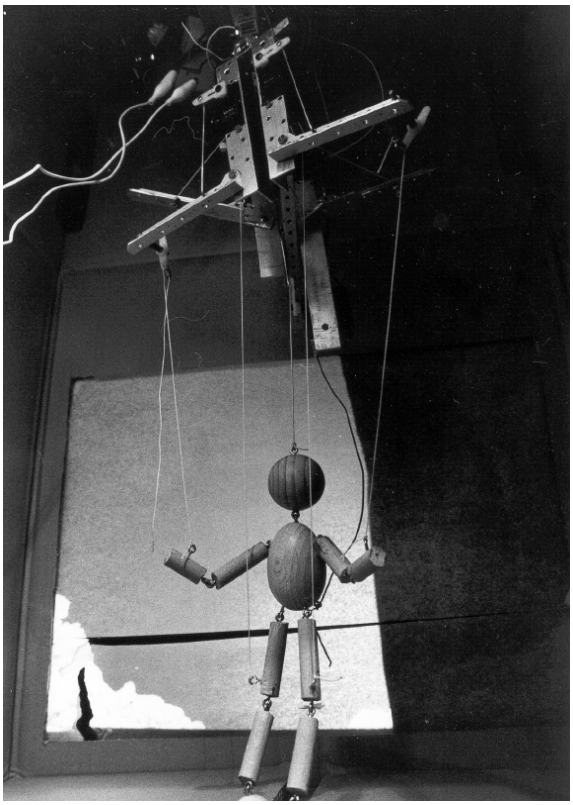

Figure 3. Concrete Marionette controlled by Servos

Figure 4. Cellist at a gallows-device

3.2 Sensoric Garden

A one-year student project focusing on control-controllability in real and virtual world, on destruction and construction of a historical theater-hill, on culture/technology and nature, resulted in a nightly open air performance in a public park. Students presented seven installations as a sensory garden. Visitors could experience various forms of human-machine interaction on the journey of a beauty statue (Gerhard Marks) through metamorphoses in real and virtual worlds. Some of them were

- Aegina, a stone woman (Figure 5), became alive as an avatar and could be moved by visitors via sensory foot-mat through a virtual world, being an abstract projection of the park on a planet surface (Figure 6),
- Temple of Philosophers (Figure 7), was a real temple-model cut by a projection wall on which two philosophers were reasoning about reality and virtuality, reacting on visitor's questions in a Weizenbaum-Eliza manner. When visitors pushed a forbidden button, the temple caught fire and could only be saved by using a real sensory air-pump to generate a simulated water-stream,
- Flirt-Machine (Figure 8), visitors could sit on a park-bank holding and exchanging markers, seeing their video-image on a projection curtain in front of them. By Augmented Reality technology (AR Toolkit [6], [4]) the markers in their hands were recognised by the system and overlaid with 3D-objects, like flowers, avatars or animals, resulting in some interesting actions and reactions of visitors with regard to their augmented doubles,
- Stone-Keyboard (Figure 7), visitors could dance on a keyboard marked on the ground and generate sound and light synchronously, giving the impression they were dancing very accurately to a given music.

Figure 5. Real Aegina

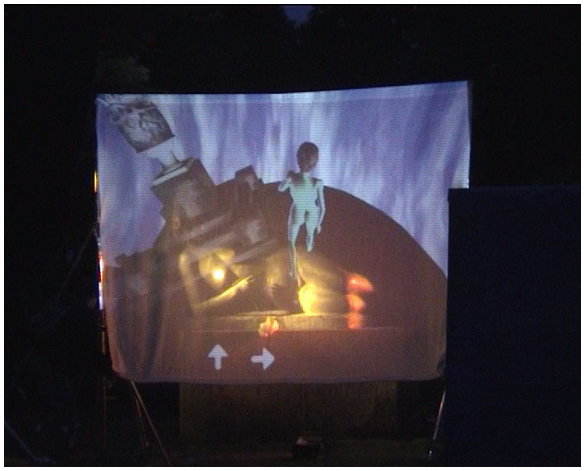

Figure 6. Aegina and her Double

A virtual interactive presentation of the event has been produced by [21].

3.3 Mixed Reality Stages

This course introduced various techniques and tools to mix real and virtual theatre scenes: AR-Toolkit [6] (see Figure 8 and 10), Hyper-Bonds [10] and Lego sensors. With LegoMindstorm programmable bricks, various creatures and mechanical devices where created to animate a paper model of the before-mentioned public park.

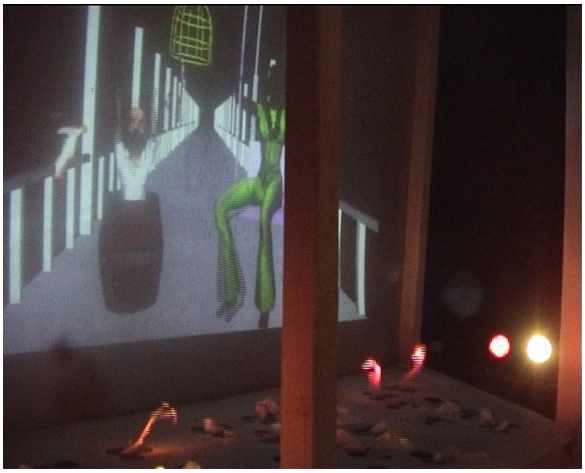

Figure 7. Temple of philosophers under Fire

Figure 8. Video Image augmented by 3D Objects

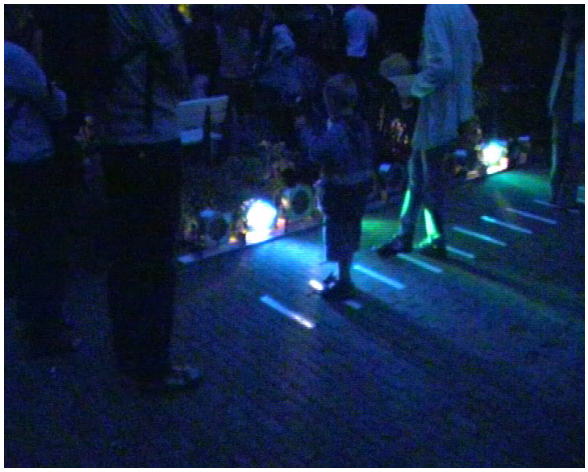

Figure 9. Sensory Keyboard generating Light and Sound

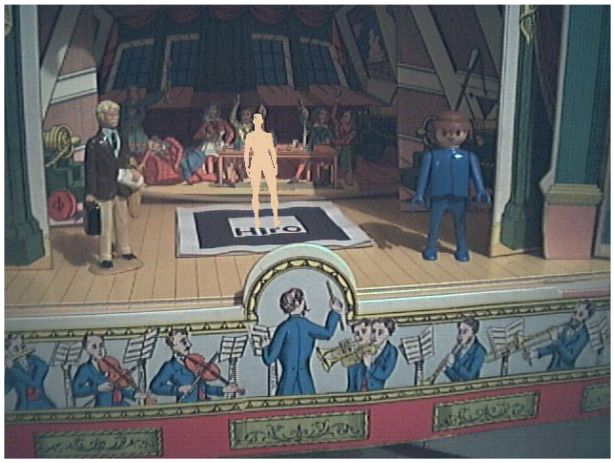

Figure 10. Projection of an Avatar into the Real Stage

3.4 A Wedding Rehearsal in Cybertown

In a project aiming at a mixed reality theatre performance, being a play in the virtual world of "Cybertown" and a performance of real actors in a room with real spectators, students were asked to imagine and concretise a character of their choice. Eighteen participants each wrote a short introductory biography of their fictional character, designed a 3D-VRML avatar with form and movement patterns and developed a common short storyboard for the play: *A Wedding Rehearsal in Cybertown*. The nonsense story was about a group of people on a way to a wedding party somewhere in the Galaxy, but as the space shuttle did not arrive, they played themselves a Wedding Rehearsal. Real players were sitting at their computers surrounding an auditorium in the centre of the real performance-room (see Figure 11 – 12). They controlled their avatars in a common web-based multi-user virtual 3D environment (cybertown), having their own perspective on the screen, looking through the eyes of their owned avatar. An additional player controlled a moving camera-avatar and this view was projected on the central wall in the performance room. The interactions in this performance where manifold: avatars built and controlled by the actors, the real actors, avatars of remote Internet-visitors and real spectators could all interact in a specific way. This performance has been further investigated [3] and compared with MEDEAEX_, a similar performance of Neora Berger Shem-Shaul [5].

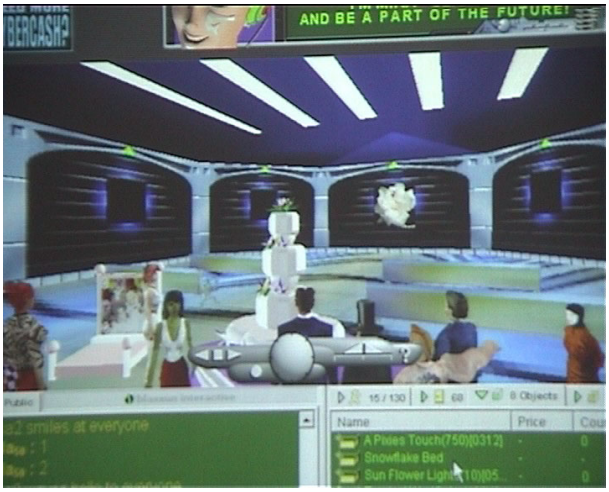

Figure 11. Wedding Rehearsal in Cybertown

Figure 12. Actors circling Spectators

4 Observation and Perspectives

Cybernetics as a science of "communication and control in the animal and the machine" might as well ask the question "what is human in machines and what is machinelike in humans, what are inner and outer determinations. After euphoric years of artificial intelligence and now humanoid robots, some old questions are still open and relevant. Who is controlling whom in a human-machine system? How can we recognise and handle the machine dimension in humans and the human dimension in machines?

Human-Computer systems have long been investigated from a usability, interactive interface perspective. Usability often was closely related to economical ergonomics. Then it was recognized to take a broader view on interaction design, seeing the function and the environment of a system in a more holistic way [11, 12, 22]. Some interesting specific position was taken by Böhle & Milkau [7], who, supported by empirical studies of automated systems in industrial applications, asked for a double perspective in the design of human-machine systems: one aiming at a rational "objective" design and one aiming at the support of a subjective emphatic relation to the machine in order to reach an overall optimal situation, in which "ironies of automation" can be minimized. Laurel [15] and Murray [19] open up another perspective on computers as theatre, focusing on the experience-dimension of human-computer activity. The orientation towards this experience-dimension possibly will have an influence on systems development [18]. The result could be more human-centered production systems. However there are further perspectives. The presented examples demonstrate how an education in automation technology, often considered from a pure scientific perspective, could be strengthened by the art perspective. Aesthetics, as a position, might be seen as a mediation between sensuousness and intellect. Its objective and purpose being the development of sensitive cognition in order to liberate ourselves from "repressive productivity" towards "creative receptivity" [17]. Play and dis-play (Schein), unproductive and useless "purposiveness without purpose" may well constitute a new position in systems design, where we focus more on contemplation/reflection than rational purpose oriented efficiency.

We could observe, that in systems design tasks, a dream oriented playful perspective may fruitfully enrich the rational and formal oriented design perspective of engineers. Furthermore, in performing art projects, the experience of a control perspective, being it for the musician or the actor or the machine in a more or less tightly driven algorithm of the author (composer, dramatist, programmer) might uncover fruitful similarities and differences of freedom of interpretation within given rules and the importance of senses and sensors as well as action and actuators. Some specific observations were

- in the industrial simulation study, as well as in the project *Theater of Machines* it was found, that a fully automated system, as first intended, was beyond economical and reliability requirements. A semi-automated implementation with some freedom for man and machines proved to be more adequate,
- in *Sensory Garden*, traditional categories of system ergonomics, like usability, proved to be rather inadequate,
- in *Mixed Reality Stages*, it could be experienced that MR as continuum of Augmented Reality and Augmented Virtuality very much depends on our focus of attention. A shifting attention of the user (similar to the shift of a bow-shooter from bow-handling to task-hitting) could identify the same system as changing from AR to AV,
- A wedding rehearsal in Cybertown revealed difficulties of communication and action in a play with changing roles and communication-rules of and between the actors.

Norbert Wiener ends his introduction to the 1948 edition of his Cybernetics Book [25] with a warning. Referring to the first industrial revolution as the devaluation of the human arm by a competition of a machinery, " .. taking the second revolution as accomplished, the average human being of mediocre attainments or less has nothing to sell that it is worth

anyone's money to buy. The answer, of course is to have a society based on human values other than buying or selling". For a teacher and scientist in production informatics the question arises, how do we analyse and construct human-machine systems in a way, open for this desirable expansion [9]. And how do we teach engineering and humanity students in this subject of *Control and Communication in the Animal and the Machine*?

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