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A. HIGH PERFORMANCE CONTENT BUSINESS

1 From Ambient Multimedia to Bio-Multimedia

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1.1 Abstract

Between user-interface design, high-quality video and audio, ubiquitous computing, pervasive designs, and advanced input devices, multimedia and its related fields transitioned from 'integrated presentation of information' (multimedia), to 'computer generated simulated environments with its peripherals' (virtual reality), 'the surround in which the user is the interface' (ambient multimedia) to this novel and newly introduced field of *Bio-Multimedia (BiMu): 'integrated human capacity'*. Multimedia and its derivates generated a cyberspace which connects people to virtual communities and experiences in ways that not only allow them to work more efficiently but also to engage in new leisure pursuits including participation in virtual sex and role play in imaginary worlds. As the next generation of mediated engagement, bio-multimedia – the integration of human capacities in a Bio-Space – serves a similar purpose: provision for leisure engagement through biological metaphor.

1.2 Introduction

The goal of this area of multidisciplinary scientific inquiry engages the disciplines of theoretical computer science, bioinformatics and systems biology, medicine, as well as multimedia; as such, it suggests a transition from the world-class concept of ambient multimedia to the next generation: bio-multimedia. The underlying question is simple - although the answer lies far in the future - beyond current bio-technological possibilities. *What challenges, possibilities, and facilities are provided by bio-technology to span a bio-space for the experience of leisure content?* The focus of this research paper is the introduction of bio-multimedia as new branch of multimedia.

Within the scope of this research work we understand under the term **synthetic space** a human created "boundless […] limited extend in one, two, or three […] dimensional extend in which objects and events occur and have relative positions and direction" (Merriam-Webster). A **world** is "the sphere or scene of one's life and action"(Merriam-Webster), which also includes 'real' and artificially created places. The term **synthetic universe** refers to "body of things and phenomena observed or postulated [for] the world of human experience [created

by humans]" (Merriam-Webster). The world is the world as it is perceived by human beings, either if artificially created or as it is in nature.

One of two viewpoints can be adopted when applying biological models and metaphors in computation:

- incorporating nature inspired behaviour into technical systems;
- building a stand-alone biological-based synthetic universe;

The first viewpoint relates to rebuilding observations and happenings from the nature or its sub-parts into technical systems.

Technical systems can be improved by biologically inspired metaphors. In contrast to re-building nature, we imagine the creation of nature or of biologically-based synthetic universes. These universes incorporate bio-feedback for reactive purposes as well as generate the actual feedback. his highly differs from the first viewpoint.

In other words incorporating nature inspired behaviour into technical systems deals with observing nature and its phenomenon. Observations are incorporated into technical systems as e.g. already applied in neural network theory, genetic algorithms, amorphous computation and the like. To build a natural or self contained biologically based synthetic universe is a rather different and more complicated task.

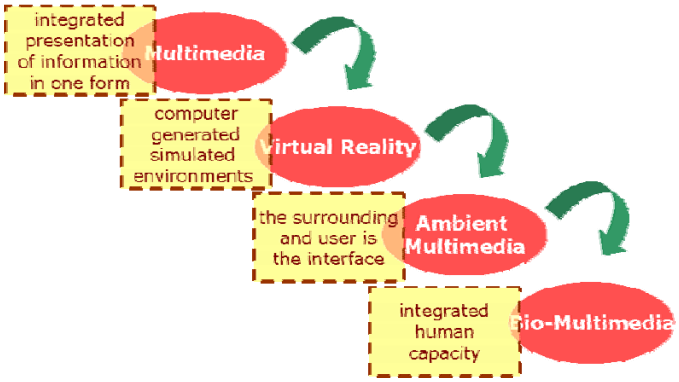

Figure 1. Development of presenting leisure content

Currently we do not have the knowledge for building a synthetic universe for trees, animals, humans, the sky or the sea. In virtual reality the synthetic universe is represented by 3D modelling languages such as VRML. A synthetic universe build on biological metaphors goes one step beyond. Let us consider an example: (Borgens) researches how to help human beings with spinal cord injury. With this approach electronic nerve impulses are generated and bridge spinal chord nerves that have been severed. What if this technique is used to interface human beings with computer systems? It could be used as novel input, as well as novel output device. Nerves are stimulated and the consumer perceives a new synthetic

universe. The issue is how to represent the universe that creates impulses? Which model language will have to be used? The nature and incorporating technical systems into the nature. The borderline between technical systems vanishes or completely disappears. In this case a technical system is better described as a certain form of techno-biological system.

1.3 Related Work

It is problematic to pinpoint on related works. Many disciplines work on this issue independently. There is less work done to bring several aspects together and present a unified theory. *Bio-Multimedia* attempts to unify these aspects and conceptualises a more unified framework. The research group "Synthetic Characters Group" (Blumberg 2000) focuses on graphical worlds in which synthetic dogs learn. The system models what we know of canine learning. A log of work is currently done with biosensors for biofeedback systems. One example is the European Biofeedback Foundation (BFE) (Foundation), which promotes the awareness of biofeedback among health care professionals. A good starting point for the exploration of biologically inspired research is (Research), that contains further links for biological inspired architectures for the brain, robotic research, bio-sensors, biological inspired computer systems among many others. A glove that senses position of fingers and creates music depending on finger positions has been presented in (Luigi Pagliarini 2002) . Another example is to create music where systems are based on natural evolutionary modes.

The MindGames group at Media Lab Europe focuses on a concept which has been termed "Affective Feedback" which asks the question: "...is it possible to constructively affect the state of the human mind through a combination of sensory immersion, intelligent bio-feedback and multi-modal interface technologies?" Technologies such as Bio-melodics, Brain Child are combined with games such as "Relax to Win" creating feedback and circumstance to inform and change the human behavioral state.

Steven Johnson reviews emergence and collective behaviour models in biology in (Johnson 2001). Interesting new thoughts of viewing digital and real universes have been presented by Bentley in (Bentley 2001). His viewpoint is to pinpoint on happening in nature and how they can transform technology. Networks and interlinked systems are nicely described by Barabasi in (Barabási 2002). More visionary thoughts about computer science and technology in general are given in (Denning 2002). First successful experiments in coping with NP complete problems by DNA computers are described by Adelman et. al. in (Adelman 1996). Algorithms used to enhance processes in nature are described by Baldi et. al. in (Baldi and Brunak 2001). Howard et. al. describe how to control computers by thought in (Howard 1999). A very comprehensive work about cell biology has been contributed by Lodish et. al. with (Lodish 2000). Amorphous computation as

another not so well known approach for biological inspired models in technology are described in (Sussman 1998)

1.4 Components

On very abstract level, the goal of any type of multimedia is to present leisure content or present content in a way easy perceivable by people. Independently where content gets presented there is one major aim valid for presenting leisure content: the consumer has to get immersed into the story, presentation or performance. On very abstract level the components for presenting leisure content are:

- *environment:* technical platform or architecture enabling presentation of leisure content (e.g. theatre stage, computer);
- *synthetic world:* soft component of the synthetic world that gets presented via the environment to the human (e.g. 3D model, multimedia assets);
- *interaction/feedback mechanism:* devices and models for altering the presentation flow that enable to interact with content either as physical entity (e.g. joysticks, cameras) or as virtual devices available in the presented space (e.g. 3D gloves are controlled via a joystick in a virtual world);
- *culture:* provisioning sociological and psychological phenomenon into fictive worlds (e.g. life-style, community building).

The environment is the technical platform for immersing consumers into the leisure content/experience. In the past this might have been the theatre stage, nowadays it is the computer and its peripherals including network facilities. The world provides the virtual or synthetic space in which the participant user becomes immersed. All fiction creates such a world. In theatre, this world is articulated on and limited to the stage, where as in massively multiplayer game the world extends beyond the action to the interaction amongst the players.

Interaction encompasses both the input method and the potential the input exerts on the flow of how a show gets presented. The audience in most theatrical performances is considered "passive" because they do not affect the dramatic flow of the story. However, for at least the better part of the 20th century examples exist of performances which incorporate mechanisms that invite the audience to "interact" in ways that affect the outcome of the story. Interaction in interactive computer mediated media is nowadays predominant, and many fictive worlds generate new cultural models for interaction and community. Virtual communities brought together by web-portals or digital chat rooms are very simple example for the integration of cultural aspects in technical systems.

A very problematic issue is how to measure quality or "good multimedia". It includes media aesthetics, social factors, human factors, usability and covers another wide range of fields. Within the scope of this research work we leave the question opened.

But what does the consumer want to do with all the components? One would like to get immersed in a factual world. Whether he watches news, surfs the Internet or studies with edutainment software, the consumer would like to sense and act in a synthetic space. Two ideas follow: first how one gets immersed into the environment and second how easily the form of the presentation can be understood. Stories provide an example. Narrative models not only cover 'story telling' they are also intended to create a compressible flow of information for the consumer.

1.5 Immersion and narrative

Immersed means "…to plunge into something that surrounds or covers; especially: to plunge or dip into a fluid…" (Merriam-Webster). To consider the borderline between illusion and reality is a useful measurement for the degree to which humans get involved in synthetic environments. It simply describes the ability of the consumer to distinguish between reality and synthetic world. A simple example is found in virtual reality (VR) and its history.

If a consumer would have been put into a synthetic universe 200 years ago, he would have perceived this world as real. He would be completely immersed in it, as he would not have been used to this world. The art of bio-multimedia now goes into a similar direction. Imagine technical possibilities in 200 years - if we would be immersed and dive into a biological space? How would we perceive this environment if we could experience it today?

One type of leisure content one can present to consumers is the creation of a fictive-world. Tribal dances, tales told around bond fires, books, movies are traditional story media. Each delivery media generates its own social conventions. Today's modern multimedia systems in the form of digital TV, video games, etc. provide a similar story sharing function in the modern culture. Bio-multimedia will go one step further, it will immerse consumers entirely and the borderline between fictive-world and real-world will completely disappear.

Let us keep with the idea of 'multimedia is telling stories' and express the thematic from the viewpoint of story telling. Story telling in any form convolves *interaction*, *multimedia assets* and *narrative*. Multimedia assets are the types of content used to present the narrative to the consumer. Multimedia assets present a world to the user. Within this world the consumer is given the potential for some amount of interaction has interaction possibilities to certain extent. This space also limits story development or narrative boundaries. In other words, all three

components of story telling create a fictive-universe where the consumer gets immersed.

To represent this fictive universe, let us take a look at Fig. 2. Each axis spans a space. The interaction space gives information about the type of possible interactions. The participant engages by interacting through within the narrative. On the other hand, the consumer travels through the representation of the narrative, i.e. through multimedia assets. The narrative space determines the type of narration and allows development, thus manifesting the story as multimedia assets.

The volume of the space gives information about potentials and possibilities of the consumer to move within the fictive world. The substance of the space is the story itself. The measurements for each axis differ.

- The interaction space is made up of interaction models (e.g. passive, input devices as well as virtual devices in a 3D world);
- the multimedia asset space consists out of the substance assets are made of, even though they might be created artificially (e.g. video, synthetic space, 3D world);
- the narrative space about limitations of narrative development (e.g. parallel or linear narration).

Seeing multimedia technology development during recent years and looking at how humans are embedded in - or are presented to - with content, we can make the following: we can make the following observation: multimedia assets represent a manifestation of arbitrary content types (e.g. images, video) evolving from monolithic assets towards ambient assets (spaces surrounding the consumer - such as a light-switch with speech interfaces) towards mixed assets (mixing the real-world elements with artificial ones) to synthetic assets completely embedding humans in an artificial world (e.g. virtual reality) and opens the possibility for creating artificial worlds which are married in the physical as well as virtual realm to human existence.

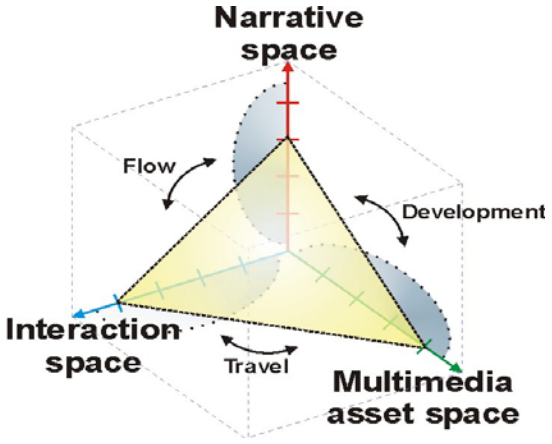

Figure 2 Narrative cube as representation for the fictive-world

Seeing our first two statements concerning creating spaces by embedding humans and leaving humans in the real world, this leaves some discussion points opened: As bio-multimedia tries to create immersion the first statement is mostly predominant. Let us consider a hypothetical example to underline our argument. A human creates a biological synthetic universe. This space is represented by a yet not known representation. VRML would be the synthetic world in computer graphics. For a synthetic universe we have currently no representational model. A human is immersed into this synthetic universe by connecting strains of nerves. Input and output operations come through them. Thus the user is left in the real world, but perceives the synthetic universe as another narrative reality. The perceiver can hardly distinguish between both realities. The consumer passes some (marginal) threshold of emotional engagement through implants. A very strong sense of another narrative reality is created.

The nature acts as source for ideas for realizing artificial technical systems. It also allows a clear distinguishing between real-world and synthetic world.

And exactly this is the task of creating multimedia, ambient multimedia or bio-multimedia: making the borderline between illusion and reality vanish. And exactly this is an excellent measurement for the quality of presenting content. It also is a measurement of how the user gets immersed into a synthetic or fictive-world. Let us look into this borderline a bit deeper:

- the borderline of multimedia is the equipment;
- ambient multimedia immerses the consumer naturally by surrounding him with multimedia equipment;
- virtual reality uses equipment for immersing the consumer, but he can distinguish clearly between reality and virtual reality;
- bio-multimedia lets the consumer dive completely into an synthetic environment, depending which technology is applied;

1.6 What now?

Still we did not consider some basic definitions and questions that are still opened and under investigation to develop the concept of bio-multimedia. Both require still fine-tuning and intelligence for bringing theoretical research in bio-multimedia into the right direction.

1.7 Definition

Definition 1: *Multimedia*. Integrated presentation of information in one specific computer generated form by involving interaction and information presentation and representation models.

Definition 2: *Ambient Multimedia.* Humans embedded into multimedia technology enabling natural interaction and seamless integration of multimedia into the natural environment.

Definition 3: *Bio-Multimedia.* The field of integrating human capacity into a synthetic service space interfaced with biological devices for immersing humans into services.

1.8 Ambient Multimedia

Between user-interface design, high-quality video and audio, ubiquitous computing, pervasive designs, and advanced input devices: Multimedia and its related fields transited from 'integrated presentation of information in one form' (multimedia), to 'computer generated simulated environments with its peripherals' (virtual reality), to 'the surrounding and user is the interface' (ambient multimedia). The concept of ambient multimedia has been developed by the IST Advisory Group as vision for European wide research.

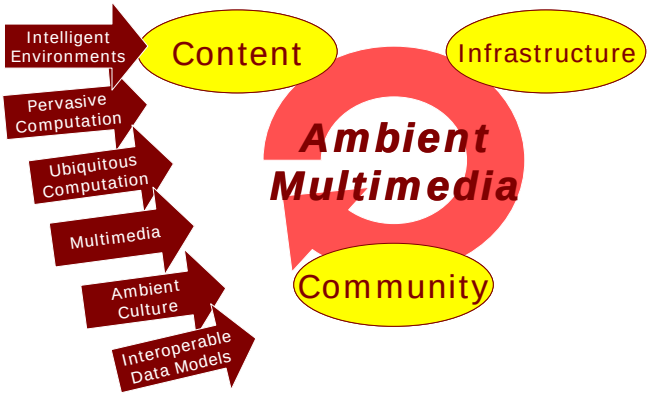

Figure 3 What is ambient multimedia?

Simply, multimedia needs more than:

- *video quality, compression and user-interface design*
- *systems where humans are surrounded by services*
- *transparent software and hardware*
- *services for the mobile consumer anywhere and anytime*
- *innovative, ambient, and wireless services*
- *business strategies to sell disruptive technology*
- *the mobile-radio-TV-lamp-computer-coffee-cup*

Ambient multimedia as based on two efforts emerged in the field of computer science recently: pervasive computation and ubiquitous computation.

Pervasive computation means "...computers and sensors 'everywhere' in devices, appliances, equipment, in homes, workplaces and factories, and in clothing. Another element involves pervasive communication - a high degree of communication among devices and sensors through a ubiquitous and secure network infrastructure with a wired core and wireless adjuncts that communicate with the core..." (Pervasive Computation)

Ubiquitous computation has as its goal "…the enhancing computer use by making many computers available throughout the physical environment, but making them effectively invisible to the user. A number of researchers around the world are now working in the ubiquitous computing framework. Their work impacts all areas of computer science, including hardware components (e.g. chips), network protocols, interaction substrates (e.g. software for screens and pens), applications, privacy, and computational methods…" (Weiser 1993).

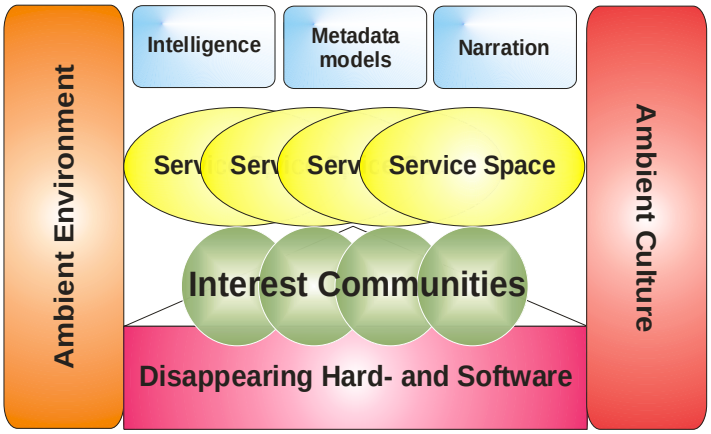

Figure 4 Principles of ambient multimedia

Extracting the principles out of both fields and merging it to new paradigms in multimedia following principles can be crystallized:

- the surrounding is the natural user interface
- location dependent and regional
- intelligent and autonomous systems
- Mobile output/input devices
- Semi-automatic adaptation to ambient user context
- Interoperability through metadata
- Semi-automatic adaptation to environmental context
- Natural user-interfaces
- Gadget-free interaction

- Interaction with content
- Intelligent context aware systems
- Creation of wireless communities
- Aesthetics and semantic content design

1.9 Bio-Mulitmedia (BiMu)

The vision of bio-multimedia is to define, create and promote the idea of bio-multimedia as new field in multimedia. Human capacity shall be interfaced with biological devices (e.g. measurement of body signals) for getting immersed into a leisure content space.

"*…creation of the transition from ambient multimedia towards bio-multimedia as concept and knowledge pool for biological inspired leisure content distribution in bio-spaces as future challenge and contribution to biotechnology…*"

1.10 Biological inspired metaphors

Biological or natural inspired computation models are already all-present. Examples are:

- Neuronal networks
- Artificial intelligence methods
- Amorphous computation
- Complexity theory
- Swarm theory
- A lot of fields contribute to bio-multimedia:
- Biometrics
- Medical field
- Human/Computer Interface
- Software development
- Biological inspired algorithms
- Biomedical hardware devices
- Human signalling
- Psychological issues

1.11 BiMu – A first definition

Bio-Multimedia integrates human capacity for spanning a bio-space for leisure content. Human capacity convolves perceptive senses, bio-signals, and interface capabilities with machinery. A bio-space is a biological inspired generated realistic environment where human capacity is integrated with peripherals.

Bio-Multimedia integrates several aspects of a human-computer interface which means leisure content creation based on human-computer interfaces. It deals with the question "Which leisure service that can be developed based on devices capturing and transmitting human signals?"

1.12 Bio-Multimedia as logical consequence

Peripherals are biological hardware components connected to equipment capable of measuring and interpreting bio signals of any type. Bio-Multimedia is the next logical step after the development of ambient multimedia services, and integrates biological metaphors and biological advances. Bio-Multimedia is the basis for integration of system components towards an integrated and embedded multimedia space for the experience of new types of leisure content.

- Bio-Multimedia is the natural temporal consequence after ambient multimedia;
- Metadata is an essential part of describing static and dynamic behaviour in form of computational models of bio-multimedia;
- Biometric systems are one example for bio-multimedia services;
- There exist methodologies and technology for creation of bio-spaces;

1.13 Components

Due to the novelty of the field, the next steps are rather hard to predict, but will evolve by following research components.

1.13.1 The Bio-Multimedia Model (BMM)

Information needs to be processed, created, transmitted, stored, and consumed based on biological inspired models. The introduction of a biological inspired logical unit for distributed data processing is required. Currently cell-based biological computer systems, based on cells consisting of infinite states, communication based on analogous models, aging, and a time based spatial (consensus) based memory, as based on a long-term construction plan (e.g. DNA) are introduced.

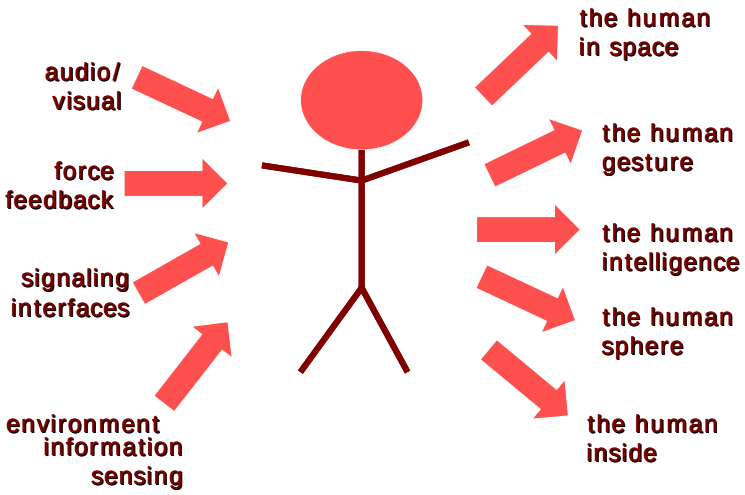

Figure 5 Interfacing humans

The main problematic is to find an abstract logic model that describes how bio computers as central processing unit might work and can be integrated with 'a life' organisms. Computational models (e.g. amorphous computation) need to be based on schemes as developed in the field of theoretical computer science (e.g. Turing Machines).

The outcome of this part would be more of abstract nature and shall identify bio-multimedia system components and requirements for integrated human capacity.

1.13.2 Intelligent Synthetic Bio-Spaces (ISBS)

The space of where to present biological inspired multimedia where human can be embedded is defined by synthetic bio-spaces. The research of the substance or model presented scenes, where integrated human capacity can interact with is scientifically researched within this work-package.

The goal is the development of a model for the presentation of content in the context of bio-multimedia, comparable to virtual reality scenes in computer graphics or 3D models. Out of which nature they are, how they are furnished, how they are artificially built, and which biological models will be used to describe them is major part of research. Metadata and new description languages are substantial part of research.

Research Component	**Objective**
Ambient Multimedia (AM)	Research of metadata its relation to bio-multimedia models, and bio-multimedia basic services as based on bio-signals, transparent user-interfaces...
Bio-Multimedia Model (BMM)	Creation of a concept, identification of its system components, and required theoretical models by integrating efforts in bio-technology;
Synthetic Bio-Spaces (ISBS)	Creation of intelligent virtual 'realistic' description for integrating human capacity with metadata models;
Bio-System Software (BSS)	Algorithms, software and data structures to be applied on a distributed bio-multimedia platform;
Bio-Multimedia Matrix (BMM)	Creation of biological inspired network and communication infrastructures including potential periphery;

1.13.3 Bio-System Software (BSS)

Research of algorithms, computational models, hardware architectures, bio-computational models, interpretation of measurements, etc. and their impact on the development of bio-multimedia as concept. Obviously algorithms, theoretical models of computation and metadata models are required for performing computational tasks within a bio-space.

1.13.4 Bio-Multimedia Matrix (BMM)

Bio-Spaces require three levels of communication models: human – bio-space, human-human, and bio-space – bio-space. The theoretical aspects and which potential communication models have to be build is of major concern.

1.14 Services

Picking the example of biometric systems: services as based on user perception are mostly based on biometric systems. Metadata is a substantial part for the description of e.g. visual features such as faces by MPEG-7 face descriptors. Fingerprints and other identification classifier provide other combination of biometric modalities. The issue is the integration of metadata models with biometric data, and the storage within distributed biometric databases.

Other closely and already now typical fields in multimedia are:

- Education
- Customer profiling & behaviour analysis
- Persons with special needs
- 'touch-less' interfaces
- 'vision-less' interfaces
- 'sound-less' interfaces
- Enjoying leisure content
- Medical analysis of patient behaviour
- Data mining
- Brain interface
- Bio-Metrics as Input Device
- Lie Detector Board Game
- Bio-Sensors in Retail

1.15 Conclusion

…simply Bio-Multimedia is novel, the bottom of the S-curve model, 'sell-ative', already hype and the future of multimedia…

1.16 Acknowledgements

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