Centrum voor Wiskunde en Informatica

**REPORT***RAPPORT*

*INS*

Information Systems

***INformation Systems***

# Capturing experience - a matter of contextualising events

Frank Nack

**REPORT INS-E0401 JANUARY 13, 2004**

CWI is the National Research Institute for Mathematics and Computer Science. It is sponsored by the Netherlands Organization for Scientific Research (NWO).
CWI is a founding member of ERCIM, the European Research Consortium for Informatics and Mathematics.

CWI's research has a theme-oriented structure and is grouped into four clusters. Listed below are the names of the clusters and in parentheses their acronyms.

Probability, Networks and Algorithms (PNA)

Software Engineering (SEN)

Modelling, Analysis and Simulation (MAS)

Information Systems (INS)


P.O. Box 94079, 1090 GB Amsterdam (NL)
Kruislaan 413, 1098 SJ Amsterdam (NL)
Telephone +31 20 592 9333
Telefax +31 20 592 4199

ISSN 1386-3681

# Capturing experience - a matter of contextualising events

ABSTRACT
This paper explores the notion of experience in the context of dynamic and interactive environments, such as web-based musea, where neither the individual user requirements nor the requested material can be predicted in advance. A definition of experiences for the particular context is introduced on which the analysis of the what (events), why (context) and the how (presentation) are based. The paper tries to identify the essential aspects of representation for the three main fields of investigation, namely content and expression for the event; goal, task action and role for the context, and the influence of event and context for the presentation. The aim is that the system can find satisfactory solutions for upcoming questions (e.g. based on the content of an image), misunderstandings (rearrangement of the material) or non-understanding (creation of a new sequence). The intent of the paper is to provide a first step towards dynamic and adaptive knowledge structures that facilitate conceptual presentations.

*1998 ACM Computing Classification System:* H5.4 [Hypertext,Hypermedia]: Architectures, Navigation, User issues. I.7.2. [Document Preparation]: Hypertext/hypermedia, Multi/mixed media.
*Keywords and Phrases:* Experiential systems, representation of events, emotions, context
*Note*: Part of the research described here was funded by the Dutch national ToKeN2000/CHIME project.

# Capturing experience – a matter of contextualising events

Frank Nack
CWI, Amsterdam
Kruislaan 413, P.O. Box 94079
1090 GB Amsterdam, The Netherlands
Tel: +31 20 5924223
E-mail: {firstname.lastname}@cwi.nl

## ABSTRACT

This paper explores the notion of experience in the context of dynamic and interactive environments, such as web-based musea, where neither the individual user requirements nor the requested material can be predicted in advance. A definition of experiences for the particular context is introduced on which the analysis of the what (events), why (context) and the how (presentation) are based. The paper tries to identify the essential aspects of representation for the three main fields of investigation, namely content and expression for the event; goal, task action and role for the context, and the influence of event and context for the presentation. The aim is that the system can find satisfactory solutions for upcoming questions (e.g. based on the content of an image), misunderstandings (rearrangement of the material) or non-understanding (creation of a new sequence). The intent of the paper is to provide a first step towards dynamic and adaptive knowledge structures that facilitate conceptual presentations.

## Categories and Subject Descriptors

H5.4 [**Hypertext,Hypermedia**]: *Architectures, Navigation, User issues.* I.7.2. [**Document Preparation**]: *Hypertext/hypermedia*, *Multi/mixed media*.

## General Terms

Design, Experimentation, Human Factors.

## Keywords

Experiential systems, representation of events, emotions, context

## 1. INTRODUCTION

Over the last 15 years a great deal of research has been directed towards the development of computer environments that seek to interpret, manipulate or generate audio-visual media either in a manual, semi-automatic, or automatic way [for visual media see 4, 24, 1, 26, 31, 9, 18, 5, 14, 3, 27; for audio see 12,32, 25, 30, 16].

All these approaches focussed either on particular intrinsic aspects of a media that the authors wished to represent or the works concentrated on a particular process that can be performed on or with the investigated media.

More recently, however, it became apparent that a more holistic view is required as we are heading towards a cyberspace as described by William Gibson in his novel *Neuromancer* [11] and envisioned by McLuhan in his work *Understanding Media* [15]. The aim is to provide a knowledge space that facilitates new forms of creativity, knowledge exploration and social relationships, mediated through communication networks (i.e. hypertext, hypermedia, interactive games, interactive information/experience systems, virtual reality, simulations, augmented reality, groupware, and so on). Such an interactive, open and multimodal system sustains the activation of articulation powers, which in general represent parts of a semiotic continuum, where verbal, gestical, musical, iconic, graphic, or sculptural expressions form the basis of adaptive discourses.

Such an individual but still communal space, in which we are able to generate, manipulate, or exchange information, is nothing more than a collective space for experiences. Those experiences can reflect the knowledge, skills and practices of an individual life. The combination of the various individual views makes up the conscious past of a community or nation or mankind generally.

It was, therefore, suggested that advances in multimedia have to address the cognitive phenomenon of "experience" [1, 28], referred to as experiential computing, as this facilitates users to gain knowledge by directly using their senses in context-based applications composed out of user adaptable event structures which usually occur in a context.

This paper describes the thoughts of the author on the representation of experience in the context of dynamic and interactive environments, such as web-based musea, where neither the individual user requirements (user and environment context) nor the requested material (domain context) can be predicted in advance. It should be made clear that the paper does not yet offer formal descriptions of what an experience is or how to describe the experience-making process. The paper should rather be understood as a first step to investigate the essential aspects of an adaptive and supportive knowledge environment and to extract the relevant research questions.

For that reason, the paper first addresses the issue of defining the term "experience". As the goal of this paper is to discuss representation issues of an experience, we then discuss the main three aspects of an experience in separate sections, namely the *what* of an experience (i.e. the event and nested event structures), the *why* of an experience (i.e. context and contexts) and the *how* of an experience (i.e. make use of experiences in an application). The paper concludes with the description of future work.

## 2. EXPERIENCE

Recent literature on experiential systems [1, 28] addresses a large number of research issues, based on the assumption that an experience is the direct practical knowledge, skill, or practice derived from direct observation of or participation in events or in a particular activity. The relevant research aspects are:

- Data acquisition and analysis based on various disparate sources (media types)
- Assimilation of information drawn from the sources based on domain-model-based techniques
- (Unified) indexing based on domain semantics rather than media type
- Exploration driven interaction where the interface maintains the state of the interaction
- Personalised presentation that considers media synchronisation and summarisation to reflect the user's (non-static) context.

The point is that experiential systems have to be multi-modal, real-time, context-aware, user-centric, and dynamic, based on the assumption that the user gains specific semantics due to direct interaction with a computer-mediated system.

The view of an "experience" taken in this paper is not very different from those described by [13, 28]. What this paper attempts, though, is to clarify a number of aspects that are implicitly touched on in the referenced papers because they are relevant for the representation of an experience in a machine accessible way.

The basis of the investigation in this paper is the following definition of experience:

> *An experience is the nonidempotent alteration of the cognitive map and/or related cognitive processes of the one who has the experience, derived from direct observation or participation in an event or activity over a certain period (short or long-term).*

The following sections are concerned with the implications of the above definition for the potential representation structures an experiential system can rely on. It is mainly the representation structures we are interested in as only a machine readable representation allows a proper exploitation in dynamic and interactive environments. The following sections discuss various aspects of an experience, namely

- the what of an experience, i.e. the essential structural elements and their attributes that are required to establish an experience, such as event and nested event structures;
- the why of an experience, i.e. the conditions in which an experience takes place, namely context structure and nested contexts;
- the how of an experience, i.e. the way we make use of experiences in an application (as we are interested in the automatic generation of multimedia presentations in dynamic, interactive but unpredictable environments, the example application is taken from the domain of museum knowledge spaces for the fine arts).

## 3. THE WHAT OF AN EXPERIENCE – EVENT

Based on our definition of an experience there are a number of compositional elements that need to be accessible so that an experience can be established, namely a person who makes the experience, actions that the person performs and an event in which the actions take place, where the event represents a spatio-temporal unit. Event and action form a natural unit and thus we discuss these two items first.

### 3.1 Event structure and attributes

An event in the context of "experience" is understood as a discrete structure of composed pre-conditions, main-conditions and post-conditions. The pre-conditions perform a type of introduction of the characteristic objects, and the locations, or moods of characters. These pre-conditions suggest certain possible directions the event can take and thus set expectations that can be fulfilled or disappointed. The particular realisation of the event may lead to certain reactions being expected or unexpected. Either way, additional clarifying information might be required, leading to another event.

Within an event certain functional elements (we actually understand actions[1] as being the core functional elements of events) are more relevant to the event or a particular stage within it than others. Indispensable functional elements are *dominant* elements of the event, whereas those that are not vital to the chronological causality are called *free* functional elements.

Imagine the event of a character attempting to obtain coffee from a coffee machine. Pre-conditions are that the character approaches an available machine. In the realisation phase of the event, the character (dominant object) searches for (free action), and then inserts (dominant action) the change (dominant object). While the machine (dominant object) is operating (free action), the character waits (free action), and finally the machine provides the cup with the coffee (both dominant objects). The event concludes with the character looking for change (free action), taking the coffee

[1]Actions define other functional elements, such as the *intentions* or *moods* of *characters,* or the importance of the *objects* involved in the actions.

(free action), and then finally drinking it (dominant action) while walking away (free action).

In addition, an event is a spatial entity where space is understood here as a cognitive-perceptive process based on lighting, sound, or setting composition.

Obviously, an event is not only the accumulation of actions, characters and objects in space but is also a dynamic entity with a beginning and an end. This temporal sequence is comprised out of two temporal schemata. One describes the factual duration of the event whereas the other one describes the perceived time. Both do not need to be necessarily the same. We are quite familiar with the situations where the actual event (e.g. a rock concert) is perceived as short by those whose expectations are fulfilled and rather long by others who got bored. As a result it is the second structure that provides information about temporal transformations that alter the cognition of an event, such as *equivalence, contraction* (e.g. ellipsis, compression), and *expansion* (e.g. insertion, dilation).

## 3.2 Macro event structures

The essential elements for causality within an event, i.e., event phase, space and time, also provide the basis for the correlative, logical relations *between* events. Here we can identify *major* and *minor* events. Major events function as selective branching points for the possible direction of the development. Major events are the target sources to retrieve information about the way an event or a chain of events was perceived with respect to stylistic devices, such as

| | |
|---|---|
| *exposition* | which provides crucial information |
| *retardation* | which delays information, |
| *digression* | which comments information |
| *omission* | which conceals information |
| *redundancy* | which intensifies significant information through repetition or opposition. |

Minor events serve the purpose of aesthetic enrichment, since they can easily be removed from the causal chain without affecting the overall understanding of the current situation the character is acting in.

The various elements and their attributes within an event or chain of events (from incident to life time) are hold together by the character that acts in the event. Yet, a lot of events serve as the ground for a larger number of characters. It is, therefore, important to distinguish between the main character(s) and those with minor roles. Nevertheless, each character provides a point-of-view on the event, where the point-of-view forms one anchor for the experience this character perceives. The accumulation of the various point-of-views might form the basis for an external character to built up her own experience of the event she is confronted with.

In fact, even that view is not completely correct; as most experiences incorporate the notion of interactivity, thus require anticipating both sides of the communication chain (expedient and percipient). The interactive aspect, might that be active or envisaged, allows a further verification of events within experiences.

## 3.3 Interactive events

Take the work with a semi-automatic presentation generation tool as example. The aim of the user is to generate a presentation and the system tries to actively support the user in getting through this experience of presentation making, including events such as decision making about form and function, establishing the logical structure, material collection and selection, presentation composition, etc. In other words the generation experience is of a referential type.

Part of the experience of "making" might be the experience of "participating", in particular when the user is looking at or investigating example presentations to collect inspirations or material for the presentation she is currently working on. Here we have the situation that new experiences are used to stimulate an ongoing experience process.

Finally, there are anticipated events that guide the making process, namely those that the potential user of the presentation might or should encounter, based on the potential meaning she assigns explicitly (conceptual) and implicitly (symbolic) to the presentation.

Thus, there are two sorts of event types that need to be distinguished: events that have a uni-directional signification structure (such as events related to the organisation of material) and those of a multi-signification nature (serving for the actual event as well as for an anticipated). It is in particular the latter type of event and its attributes (e.g. actions) that are of interest for the representation of events, as they function as mediator between actual experience and envisioned experiences.

The very short analysis of an event shows that it is a dynamic psychological entity that refers to mental states, surface structures (*expression*) and deep structures (*content*), embedded in a communicational process. However, it seems to be necessary that the communicational process needs further distinctions than content and expression. These additional differentiations concern *substance* and *form*, where substance represents the natural material for content and expression, but form represents the abstract structure of relationships that allow the interpretation of the knowledge space with respect to physical content and related intentions or expectations. Figure 1 shows the relationships between the differing structures found in an event.

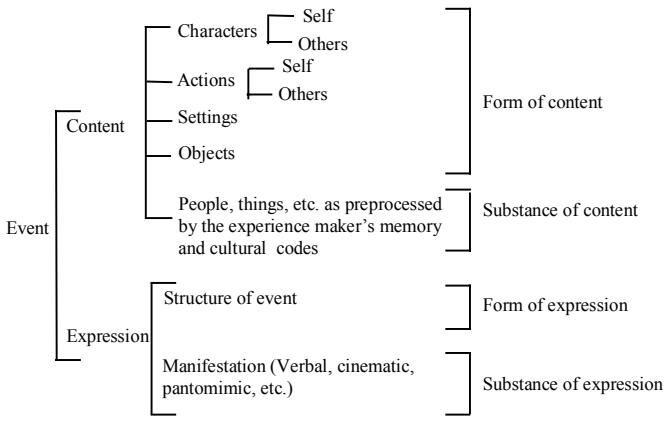


**Figure 1: Relationship between event elements (adapted from Chatman (1978, p.26))**

It needs to be emphasised that the process of signification is based on a myriad of perceptual, cognitive and cultural codes embedded in the various possible substances of expression. Thus humans have to learn how to interpret them on various levels of detail. This process of interpretation varies from individual to individual. Moreover, expressional signification, though based on common human knowledge and thematic structures, provides its own temporal-spatial realities based on patterns of juxtaposition, which are interwoven in the narrative structure. For the representation and use of various media in dynamic digital environments this means that we have to represent both its denotative and connotative aspects. It is clearly the connotation that relies on the denotation. This means that we can use the denotative representation to analyse, interpret or generate connotations on visual material but we cannot deduce denotative aspects of visual material on the mere basis of connotative descriptions.

## 3.4 Discussion

For the representation of an event within an experiential-oriented knowledge space a number of perspectives can be drawn from the above analysis.

### *3.4.1 Event representation – attributes*

The representation of dominant attributes in an event is crucial, as well as the identification of dominant events within a chain of events. This can only be achieved with a clear understanding of the domain (both content and application). The problem is to determine the smallest required set of schema to describe an event, its attributes and the relations between them, so that it is still able to provide the means to (re)establish an experience. It is important to state that what is described here loosely as attributes of an event are themselves semantic structures describing simple codes, i.e. collections of objective measurements for media units representing prototypical content or style elements, which are combined with high-level conceptual descriptions supporting contextual (episodic) and presentational requirements. The definition of those structures, however, does not solve the problem of how to instantiate them.

### *3.4.2 Event representation - presence*

Related to the point made in 3.4.1 is the aspect of "presence". Storing an experience in memory is always a retrospective act, as the experience has to be necessarily over to be fully established. A minimal set of descriptive structures might help to capture the essence while still present.

Transmitting the experience while it is happening also profits from a minimal set, as the swiftness of "quasi presence" demands controlled distribution. Yet, we will face the problem of mapping two different minimal sets, namely the one from sender and receiver (dominant reading, negotiated reading, oppositional reading), The aim, therefore, should be to establish minimal sets on a unified foundation, based on domain semantics. Note, even though the structure of the minimal set remains identical, its semantics might change due to the domain semantics applied to it.

The challenging aspect of minimal descriptive sets is the (re)generation or (re)application of an experience, as only in generation or application it becomes apparent if the represented experience achieves the desired effect.

### *3.4.3 Event representation – temporality*

As an experience is embedded in a temporal continuum it is important for representational purposes to facilitate an ongoing process of inspection and interpretation based on the perceiver's presuppositions at the time of perception along with the various legitimated codes and sub-codes the receiver uses as interpretational channels at that time. This requires, however, flexible structures with respect to re-evaluating events on attribute level as well as reshaping relations between and within events on a spatio-temporal, and object inherent semantic level (for a detailed analysis of the problems of describing objects and their spatio-temporal as well as semantic relationships in visual media see [19]).

### *3.4.4 Event representation – interactivity*

In an interactive setting it is essential to enhance the representation of an experience with other information (which can be another experience), thus changing an instantiated representation without deleting it. In other words, an experiential system makes various degrees of cognition accessible, and keeps them, as they might be illuminative for other interests. Related questions are:

- What are the various types of event and their communication abilities (uni- or multi-signification)?
- How is the point-of-view to be integrated into an event and what does this mean with respect to

event representation and inter-event representation?

- How much information in an event and how many events need to be stored to avoid redundancy problems (events are the basis for continuity and thus the essence of the nonidempotent quality of experiences)

So far we mainly investigated the content level and related issues of an experience. Yet, an experience is not an isolated item but usually occurs in a context. Thus in the following section we extend the current view by including the concept of "context" in our discussion.

# 4. THE WHY OF AN EXPERIENCE - CONTEXT

With respect to our definition of an experience, as described in section 2, the process of making an experience is triggered by events that are either observed or participated in, where the interpretation is based on events that one personally encountered, underwent, or lived through. All these influences elucidate the importance of context. Yet, the difference types of influential sources clearly indicate that the concept of context is not a secluded but rather an amalgamation of concepts. This section tries to clarify this assumption.

Context is understood here as interrelated social and cultural conditions in which something exists or occurs. The aggregation of these conditions influences the life of an individual or community.

## 4.1 External and internal context

At first a distinction can be drawn between external (environment, data) and internal context (metadata). The external context provides the various sources that influence the cognition of the perceiver with respect to a media item. Take an image, such as the "Kitchen Maid" by Johannes Vermeer as shown in Figure 2.

As reader of this article you see the print of a digital reproduction of the original. You know, however, that the original image was painted with oil. Most likely you would perceive the painting differently in room 218 on the second floor of the Rijksmuseum, where you could see it not only in its original size but also in a physical environment that tries to do justice to the time when Vermeer painted it (the other paintings provide references to the time as well as to the concept of a "Genre painting[2]"). Again differently would be your perception of the painting on the web site of the Rijksmuseum, where in the "collection" section you not only can have a look at a high-resolution version but also get additional information accompanied with it (http://rijksmuseum.nl/asp/framuk.asp?name=collectie).

Even if we exclude the environment, might it be this text, the museum room or the museum web site, the painting itself contributes to the sphere of external context with respect to its content, such as subtle lighting, simplicity – a servant painted from a low viewpoint, uncluttered background supporting a clear composition, etc.

**Figure 2: The Kitchen Maid (ca. 1658) by Johannes Vermeer, oil on canvas, 45.5 x 41 cm, SK-A-2344, Rijksmuseum Amsterdam.**

The internal context, on the other hand, enables the perceiver to emphasize, interpret and evaluate the sources based on the comparison with existing memory structures (the inner world model). Each reader will evaluate the elements of form, line, and colour with respect to their intrinsic interests and significant weights that counteract, reinforce, counterpoint or balance each other in complex systems, each read against your expectations of the frame combined with the sense of composition in depth and planar design. Additional influences on how you perceive the painting here in the article is the level of importance you assign it to the current argument, as well as the level of your personal likings (tough for the author of this paper if you dislike Vermeer), your current mood (you have to read it, you like reading it, etc.) and other physical conditions (tiredness, hunger, sounds you hear in your surroundings, etc.).

There is a relation between external and internal context that can be seen as follows: if necessary the inner model needs adaptation forced by external sources (learning), which then will influence the reactions of the perceiver once she acts as creator (development). Thus, both external

[2] Genre paintings, drawings or prints depict people in their everyday surroundings: at home, in a café or at work. They appear to be painted from life, but in reality were usually thought up in the artist's studio.

and internal context are necessarily related without being identical[3]. This is an essential point, as we will show later that experiential systems usually operate in and on the external context whereas the inner context, which forms the essential aspect of the experience making process, namely the evaluation and instantiation, is hardly ever modelled and is, therefore, in the best case anticipated in the system design.

## 4.2 Sources of context

Section 3 listed some of the external sources, such as character, action, object, setting, which are clustered in complex event structures. We also pointed out that the aim is to represent events in minimal description sets. As diverse contexts will use the sets differently it is important to be able to provide a mechanism to emphasize the importance of a source for a context, as this importance value essentially enables selecting the relevant items that facilitate the representation of the experience towards which the effort is directed. This might be no problem if the intend is to represent the experience once established; but even then the user might not be in a position to state what experience she went through. The case is different if the system should be reactive (such as in interactive environments) where an anticipation of occurrences is required. Here the final experience is not known beforehand and thus the system can only rely on detectable triggers of the "experience generating process" to determine what is relevant. Such a trigger is the goal of the user. The goal can be activated by the external context (e.g. the assignment to make a presentation about an art style of one's choice) or by the inner context (e.g. to play a racing car game to release tension). Moreover, a goal has a duration, namely short-term (fix a problem now), medium-term (finish the assignment as good as possible) and long-term (become famous).

## 4.3 Goal Structure – a context trigger

A goal itself relates, once instantiated, instantly to the external and internal context, regardless from which side it was activated, though the more relevant context substantially influences the structure of the goal.

Take the example of a first year art student who's task it is to make a presentation about an art style of one's choice. The goal was stimulated by the external context (professor decided about task, professor will decide about mark) and thus external elements will mainly shape the goal and sub-goal structure(s). For our example the main goal structure includes certainly duration among other elements, as it is the duration that determines the definite end of the goal fulfilment process. Yet, this strict duration also influences the level of detail that can be covered with respect to the content to be presented (external context). The encountered restrictions will most likely stimulate the choice of the topic, depending on the existing domain knowledge of the student. This, however, is an aspect where the inner context might have an influence on the goal structure too, as the actual amount of time and work spent on solving the task depends on the determination of the student to get a good result or a mere pass. Further causal steps can be foreseen. However, even if all the in-between steps are solved satisfactorily - the end presentation might be good, the mark might be outstanding – it might be that the overall experience is evaluated as not satisfying by the student as new discoveries were not made because the student played safe and went for an art style she knew well and used a tool she knew insight out.

## 4.4 Satisfaction – the relevance of the inner context

The element of satisfaction is such an important element for the evaluation of an experience that it can be found as structure element in the various substructures of the goal fulfilment process, namely tasks (pieces of work to be finished within a certain time that help achieving the goal) and actions (a set of functions to accomplish a task usually over a period of time, in stages, or with the possibility of repetition).

As actions were identified earlier as an important element of an event (the main manifestation of the experience-making process) and are present as the smallest unit within the goal fulfilment process we look at them here in a bit more detail, in particular by focussing on the process of satisfaction-based evaluation.

Semantically, an action can be represented on a physiological level (bodily function, change, contact, creation, motion, perception) as well as on a semantic level *(cognition, communication, emotion,* and *social interaction*). In the case of our student who is building a presentation the picking of objects from the displayed set of retrieved information items and assigning them to the current structure element (i.e. the introduction) are typical actions on a physiological level. This level of an action is visible and thus measurable. The reasoning behind the actually performed actions, namely the selection of particular items for the introduction and the evaluation on an emotional level for both actions and selected items, thus the inner context, remains hidden.

An important inner aspect is, for example, the mood that represents the emotional value assigned to the doublet

[3] The interplay of external and inner context describes the attempts of humans to understand the world – an attempt that takes a whole life and will never succeeds. That is why external memory structures are required, such as books or hypermedia systems, as they offer the option to make knowledge timeless, though to some extent they are illusionary as it would take more than a life time to analyze them. Hence all our efforts to make the essential information available once it is needed in a presentational form that is appropriate.

(action + object the action is performed on) [22]. The structure of such a value, which is called mood symbol from now on, represents an emotional classification, based on hierarchically ordered classes, i.e. pleasure and displeasure, where each class in itself denotes a hierarchical representation of emotional states, i.e. for pleasure (delight, ecstasy, euphoria) and for displeasure (unease, dissatisfaction, distress). A mood symbol plays an essential part in the representation of an experience on various levels, where an inheritance mechanism allows the accumulation of mood symbols from the simplest action up to the goal level. Every new experience process relies on already established symbol pattern as they provide a simple but essential means to evaluate the external sources based on existing experiences.

Returning to the example of selecting pre-sorted and arranged material we can imagine that the user is in a stress situation (the presentation has to be handed in tomorrow, the mark is relevant for a grant and the professor usually does not allow extensions). Now, if the material is not what the student wishes to use, resulting in a number of refinement steps for the search, the mood token for the search as well as for picking and the picked objects might be on the negative side (the student had an idea but could not really get what she wanted). Even if the end result might be sufficient, the experience with parts of the "presentation" tool is negative and might result in avoiding it for similar tasks all together, despite the fact that other circumstances might be applicable at that time, e.g. no stress.

Figure 3 is a simplified representation to describe the above process graphically. Note that the right block of action represents the "external" context and it is this aspect that reacts on the presentation, whereas one outcome, namely the mood token affects the inner context of the action.

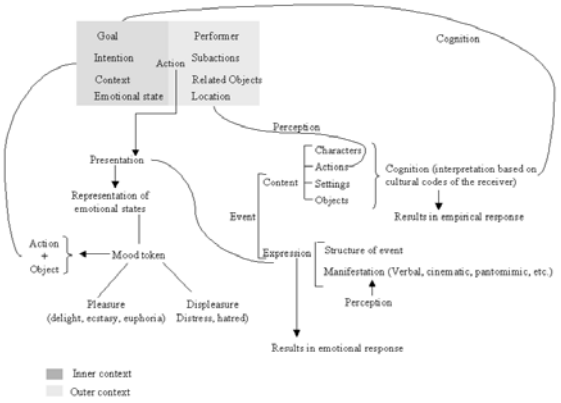


**Figure 3: A simplified model of "satisfaction-based" evaluation of an action**

Similar processes are performed on all other attributes as being discussed in section 3 (events). The balance of the weights through the various hierarchy levels is an essential aspect of the representation of an experience – and the (re)application or (re)generation of an experience depends very much on the ability of a system to interpret the various values.

It seems implausible, however, to detect and represent all these subtle differentiations of the inner context (as most humans don't even understand them – if we did we probably would not need long psychological treatment to uncover the damage an experience performed).

## 4.5 The presentiment of inner context - roles

There are inner processes that have a manifestation in the external context, such as the role character or objects are playing.

Roles for characters are seen as a socially expected behaviour pattern usually determined by an individual's status in a particular society. A role for an object, might that be a physical object like a cup, or a more abstract concept like a paragraph in a text, is understood here as a function or part performed especially in a particular operation or process.

Both views on a role are important as they provide the means to access and use the inner symbol system. For example, depending on the social role of a task requester we will evaluate particular tokens differently. Building a presentation because it is asked from a superior, such as a professor (liked or disliked) will trigger a different set of symbols than building a presentation on the same topic for a loved one.

Additionally, we see similar role behaviour in the data that forms the building blocks of an experience or the environment that allows us to create or manipulate the data. Tools are designed for particular tasks, often even for a particular domain, but we have no problem in using the tool for different tasks or the same tasks in a different domain if we can see that the aimed-for result can be achieved (same application different context). An example on data level might be a video clip about a heart operation that can play the role of an explanation in an educational environment (as it shows a particular operation technique) but might also perform as the crisis element in a drama where it represents a critical situation of the patient (change of structure context).

The important aspect of the discussion of context is, with respect to its representation within experiential systems, that the representation of the inner context is essential. Yet, it seems that the interesting aspects are hard if not impossible to model or if not to model then to be initialised (where should we get the data from) and maintained. Thus, implicit modelling of inner context in events and contexts (external context) seem to be the solution – which is in

particular relevant for systems that automatically generate content.

What we have to be aware of is, however, that experiential environments are necessarily simplifications and thus need excessive testing before they are exposed to the real world. If the inner context of the user is misjudged, the system could easily result in negative training results or increased phobia or post-traumatic stress disorder – outcomes that are unwanted [29].

## 4.6 Discussion

For the representation of context within an experiential-oriented knowledge space a number of issues can be drawn from the analysis in this section:

### *4.6.1 Context representation – external*

The representation of external context is essential. The level of detail needs to be investigated but has to reflect the domain, with respects to roles, goals, tasks and actions, related to the various objects and characters (the representation has to cover content and process). Thus, experiential systems are necessarily domain dependent.

### *4.6.2 Context representation – internal*

The question of how to model aspects of the inner context is more difficult. Assuming that the minimal set of dominant event aspects is established for a domain, it might be possible to assign a minimal set of parameters that allow an assumption about how an experience can be perceived. The challenging aspect of a minimal descriptive set of parameters is, however, not so much its design but rather how it can be instantiated for the particular user it is supposed to be describing.

### *4.6.3 Types of contexts – how many?*

As pointed out earlier, the domain influences the experience on the content as well as skill/practise level. For example, the task context of presentation generation has relations to the style context, structure context and the various actions that can be performed in these contexts. Thus, an interesting question is how many contexts do exist, how are they organised (paradigmatic or syntagmatic) and on which level do they interact with each other (e.g. might it be possible that the less complex modality context can overwrite a substantially more complex culture-context, see Figure 4 as an example).

### *4.6.4 Change of perspective*

How to model the change of perspective in context is difficult too, as the mere storage of states (as described in point 3.4.4 in the summary of section 3) is not sufficient. The problem here seems to be the extreme variability of tokens - change of state and availability based on the current inner and external context in combination with the established states of tokens in related experiences. In other words – the problem is to represent the procedural aspects of an experience (the hermeneutic circle or spiral[4], depending on how you see the process of interpretation).

### *4.6.5 Evaluation of similarity between contexts*

A relevant question is how "related" or "similar" instances of experiences can be identified so that comparisons can be made. The problem here is that the semantics of the relations in an experience and between experiences need to be made applicable to allow various sorts of applications (manipulation, generation, transformation of content, structure, etc – whatever the current action requires). In fact what that is hinting at is the question of creative use of material triggered through experiences.

### *4.6.6 Facilitating the distribution of an experience*

Another challenging aspect is how to provide a user willing to share an experience with an interface that facilitates the provision of information on the various levels of internal and external context. The aim is to provide tools that support the quick identification of dominant content aspects and their relation to emotional states.

Having investigated the two most important aspects of an experience to be represented, namely event and context, it is time to investigate the problem of how to establish an experience. The next section briefly investigates, therefore, the problems of interactive presentation.

# 5. THE HOW OF AN EXPERIENCE – PRESENTATION

In section 2 we defined the term experience and stated that the experience is derived from direct observation or participation in an event or activity over a certain period (short or long-term).

In section 3 we argued that the macro structure of events provides the skeleton for the experience-making process and outlined in section 4 that events are routed in a particular context. Both elements together form the cultural process of "narrative"- the basic way of making sense of our experience of the real. Since the relationship between narrative and reality is important with respect to the representation of experiences it is useful to quickly examine it.

[4] The phrase "hermeneutic circle" refers to the circle of interpretation necessarily involved when understanding some work of art. It is a way of explaining and expressing how understanding and interpreting a work of art is an ongoing process which takes time. As more information about the work is acquired, an interpretation gradually changes to incorporate that. Those who argue that no attempt at interpretation can ever reach any sort of closure will refer to this as a hermeneutic spiral, because it simply goes around and around forever.

## 5.1 Narrative and realism

Narrative is a strategy that tries to construct a self-contained, internally consistent world that is real-seeming. This does not mean, however, that the narrative is an objective reproduction of the real world, but that it appears to be supervised by the extent to which the common-sense conventions that structure our understanding of the real world appear adequate to decode the fictional world.

The concept of realism imposes coherence. The fictional world must appear self-sufficient and unbroken: every detail in the fictional world makes sense and everything we have to know in order to understand it must be built-in, and anything that contradicts or disturbs this understanding must be excised.

The importance of narrative in particular in the process of experience-making directed research in experiential system design to investigate game structures, as in games the two aspects of the players' experience are the goals they follow and the environment in which they pursue them.

## 5.2 The game metaphor

Experiential systems, following the game metaphor, as described in [1], skilfully make use of narrative structures (reduction of outer context with the effect that the artificial story world is under control) to shape the user's perception and emotions (reduction of the potential inner context as the user is forced into a set of tasks that cover a certain set of expected experiences). Thus, most of these applications follow the approach outlined earlier to model the external context and try to envision the inner context of a user who is eager for the experience.

The main focus of most of the described systems, however, is put on the ability to immerse the user and a great deal of work is directed towards the creation of reality with respect to the presentation of content as well as the performance of tasks within the established context. The richness of compelling interfaces used covers:

- 2D flat-panel display mounted on a mechanical 3D space tracking armature that allows the inspection of virtual 3D objects while keeping the interaction rooted in the physical world;
- an embodied virtual-actor software system in which actors have the ability to interactively vary their body language to convey personality and mood change;
- a mission rehearsal system to train decision making in a variety of situations that occur in peace-making and disaster-relief missions, where the trainee is confronted with events presented on a 30-foot-by-8-foot curved screen provided with surround-sound systems;
- virtual environments that make use of high quality sensory immersion to achieve the immersion of the user;
- sociable robots that perceive the behaviour of human beings through vision, sound, and touch.

The question these systems try to solve seems to be of how much simulation of reality is useful in creating a believable experience resulting in the best possible immersion, as it is immersion that provides the ground for motivation and concentration to achieve the goal.

## 5.3 Immersion and abstract material

This point of immersion is important and was only implicitly covered in our discussion of event and context. The reason for this is that our starting assumption is different. The knowledge spaces we are working with do not necessarily require the simulation of reality[5], as we are interested in the presentation of information in a way that, like in most research in arts and humanities, follows an interpretive, associative method based on historic-cultural materials, including primary sources as well as secondary materials.

Our work is, therefore, directed towards the creation of presentations that allow the interaction with "artificial" knowledge spaces that provide information on the relationship between multi-modal units and the ideas they represent. These environments are dynamic, such as web-based musea, where neither the individual user requirements nor the requested material can be predicted in advance and thus contrast to the highly predefined environments describe in section 5.2.

Thus, we generate non-permanent presentations of non-static spaces, where the abstract, stylised and non-real presentation is a feature. In such applications, the planning of the "experience", namely by providing the narrative and the appropriate presentation aesthetics, needs to be done to some degree automatically. This requires, however, that the various levels of event and context need to be made as explicit as possible.

The presentation itself represents a sub-part of the source knowledge space (which can be composed out of various data bases), which provides a particular point-of-view on the available material. As the user of the presentation environment can interact with it, the presentation is in fact an evolving representation of the knowledge space. With evolving we refer to the concept of *progression of detail* that facilitates navigation based on a given weighted set of descriptors representing a story context on a micro level (next step in content exploration) as well as on a macro level (larger contextual units clustering content, such as classes of artefacts within an art movement), as described in [8], only that we try to integrate various context levels at the same time.

[5] We do note, however, that not all of the simulations described in the special issue follow the approach of simulating reality.

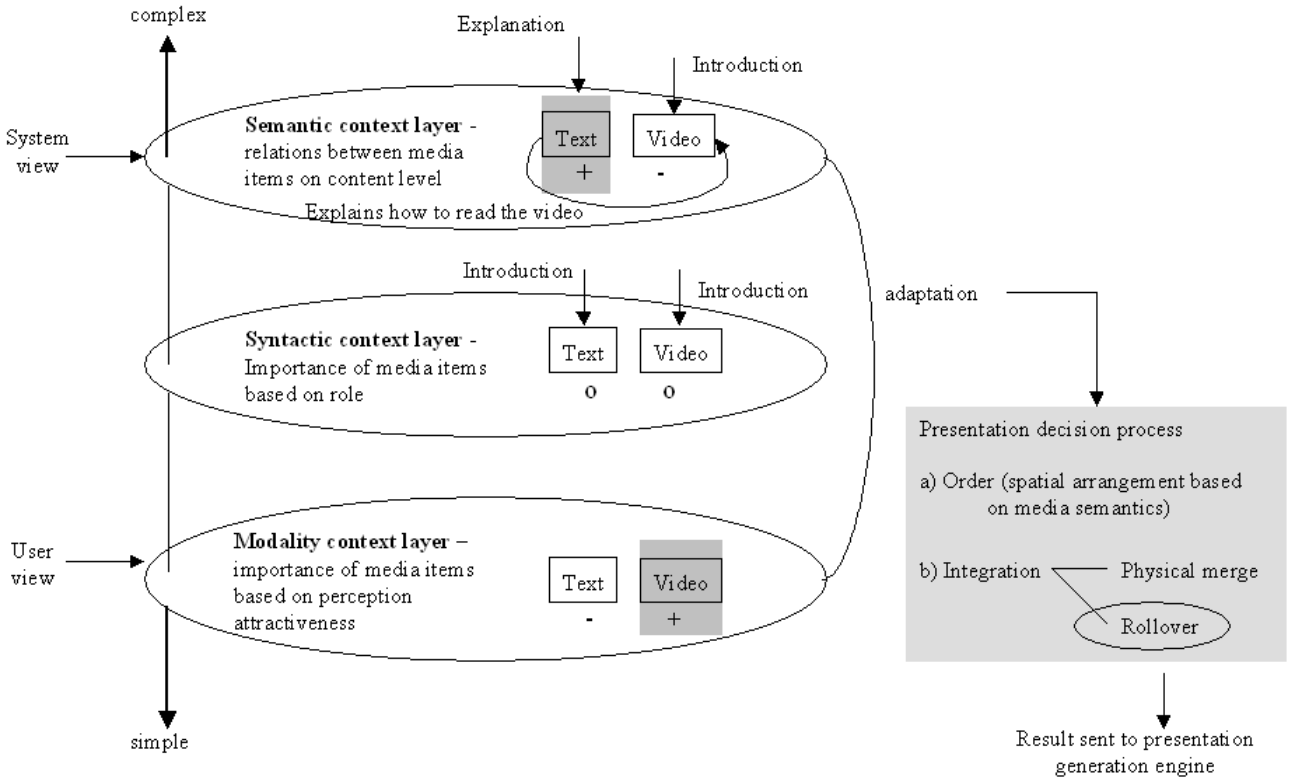


**Figure 4: The influence of various context attributes on the determination of presentation technique for a text and a video unit in an introduction page.**

Figure 4 describes an example where the actual representation strategy (show text when mouse rolls over video) is based on the roles of the applicable information units (text and video) balanced by the various contexts they can perform in an introduction page of a large-scale multimedia presentation.

The aim of our work is to merge aspects of the external and internal context to be able to access the memory of every single user by working on primary sensory material, such as sound, colour, or light reaching the deepest layers of the emotional memory. Using such a combinatorial approach it is possible to establish conceptual presentations that support a better understanding of art, so that the system can find satisfactory solutions for upcoming questions (e.g. based on the content of an image), misunderstandings (rearrangement of the material) or non-understanding (creation of a new sequence).

## 5.4 Discussion

The two approaches towards "experiential systems" outlined in this section point to the following problems:

### *5.4.1 Classes of experiential systems*

Is it useful to build a classification of experiential systems to identify their approach towards the representation (explicit or implicit) of the various internal and external level within experience?

### *5.4.2 Modularization of experiences*

Is there a way to modularise experiential systems to make a reuse of structures or memory settings possible?

### *5.4.3 The level of simulation of reality*

What levels of reality and presence are actually necessary to establish experience?

## 6. Current status

In this paper we explored the notion of experience in the context of dynamic and interactive environments. We tried

to identify the essential aspects of representation for the three main fields of investigation, namely event, context, and the influence of event and context for the presentation of information and concluded that the representation of an experience is only partially possible, as the process itself cannot be captured.

In the Cuypers system [23] we try to address the issues raised in the analysis provided in the paper. The approach we choose is to provide the system with knowledge of simple codes, i.e. collections of objective measurements for media units [21] representing prototypical style elements, which are combined with high-level conceptual descriptions supporting contextual and presentational requirements [20, 10]. The architecture includes 5 modules, namely the user module, the platform module, the discourse module, the domain ontology, and the design module, covering the various knowledge representations in the form of facts and task-solving routines (mainly constraint solving) required during the presentation generation process. The presentation engine controls the organisation of this process.

In the context of the current CHIME [7] project we are investigating, in particular, ways of representing user interaction as part of event structures, monitored over time and analysed in the given context to allow an adaptation of the environment to the user needs over a longer period of time.

## 7. ACKNOWLEDGMENTS

Part of the research described here was funded by the Dutch national ToKeN2000/CHIME project. The author is grateful to the Rijksmuseum in Amsterdam for their permission to use an image from their collection for this paper. The author also wishes to thank in particular his colleagues Lynda Hardman, Jacco van Ossenbruggen, Lloyd Rutledge, Katya Falkovych, Yulia Bachvarova, Stefano Bocconi, Joost Geurts and Katharina Schwarz for useful discussion during the development of this work. The author would also like to thank Hari Sundaram for interesting insights into the process of representing performances. Finally, the author wishes to thank Marc Davis for interesting discussions on the nature of communication.

## 8. REFERENCES

[1] ACM Communications (2003). A game experience in every application. Communications of the ACM, July 2003, Volume 46, Number .

[2] Aguierre Smith, T. G., & Davenport, G. (1992). The Stratification System. A Design Environment for Random Access Video. In *ACM workshop on Networking and Operating System Support for Digital Audio and Video*. San Diego, California

[3] Bailey, B. P., Konstan, J.A., & Carlis, J.V. (2001). DEMAINS: Designing Multimedia Applications with Interactive Storyboards. In Proceedings of the 9th ACM International Conference on Multimedia, pp. 241 -250, Ottawa, Canada, Sept. 30 - Oct. 5, 2001.

[4] Bloch, G. R. (1986) *Elements d'une Machine de Montage Pour l'Audio-Visuel*. Ph.D., Ecole Nationale Supérieure Des Télécommunications.

[5] Brooks, K.M. (1999). "Metalinear Cinematic Narrative: Theory, Process, and Tool. " MIT Ph.D. Thesis.

[6] Chatman, S. (1978). *Story and Discourse: Narrative Structure in Fiction and Film*. New York: Ithaca.

[7] CHIME (2003). http://homepages.cwi.nl/~media/projects/CHIME/

[8] DAVENPORT, G., and MURTAUGH, M. ConText: Towards the Evolving Documentary. In ACM Multimedia '95, Proceedings, pages 377-378, San Francisco, California November 5-9, 1995. ACM Press.

[9] Davis, M. (1995) Media Streams: Representing Video for Retrieval and Repurposing. Ph.D., MIT.

[10] Geurts, J., Bocconi, S., Ossenbruggen, J.v. and Hardman, L. (2003). Towards Ontology-driven Discourse: From Semantic Graphs to Multimedia Presentations. Proceedings of the 2nd International Semantic Web Conference (ISWC2003). Sundial Resort, Sanibel Island, Florida, USA, 20-23 October 2003. http://iswc2003.semanticweb.org/

[11] Gibson, W. (1986). *Neuromancer*. Phantasia Press, 1st Phantasia Press ed. West Bloomfield

[12] Hirata, K. (1995). "Towards Formalizing Jazz Piano Knowledge witha Deductive Object-Oriented Approach". Proceedings of Artificial intelligence and Music, IJCAI, pp. 77 – 80, Montreal.

[13] Jain, R. (2003). *Experiential Computing.* Communications of the ACM **46**(7): 48-55.

[14] Lindley, C. (2000). *A Video Annotation Methodology for Interactive Video Sequence Generation,* BCS Computer Graphics & Displays Group Conference on Digital Content Creation, Bradford, UK, 12-13 April 2000.

[15] McLuhan, M. (2001). Understanding Media. Routledge Classics, London and New York.

[16] Melucci, M. & Orio, N.. (2000). SMILE: a System for Content-based Musical Information Retrieval Environments. RIAO' 2000 Conference proceedings, Vol 2, pp. 1261 - 1279, Collége de France, Paris, France, April 12-14 2000

[17] Merriam-Webster Dictionary (2003): http://www.m-w.com/cgi-bin/dictionary

[18] Nack, F. (1996) "AUTEUR: The Application of Video Semantics and Theme Representation in Automated Video Editing," Ph.D., Lancaster University, 1996.

[19] Nack, F. & Hardman, L. (2001) Denotative and Connotative Semantics in Hypermedia: Proposal for a Semiotic-Aware Architecture. *The New Review of Hypermedia and Multimedia 2001, Vol. 7, pp. 39 - 65.*

[20] Nack, F., Windhouwer, M., Pauwels, E., Huijberts, M., & Hardman, L. (2001). The Role of High-level and Low-level Features in Semi-automated Retrieval and Generation of Multimedia Presentations. CWI-technical report, INS-R0108, 2001.

[21] Nack, F., Manniesing, A, & Hardman, L. (2003) Colour picking - the pecking order of form and function. to appear in Proceedings of the 11th ACM International Conference on Multimedia, Berkeley, CA, USA, November 2-8, 2003

[22] Ortony, A., Clore, G. L., & Collins, A. (1988). *The Cognitive Structure of Emotions*. New York: Cambridge University Press.

[23] Ossenbruggen, J. v, Cornelissen, F., Geurts, J., Rutledge, L., & Hardman, L. (2001). Towards second and third generation Web-based multimedia In: The Tenth International World Wide Web Conference, May 1-5, 2001, Hong Kong.

[24] Parkes, A. P. (1989) *An Artificial Intelligence Approach to the Conceptual Description of Videodisc Images*. Ph.D. Thesis, Lancaster University.

[25] Robertson, J., De Quincey, A., Stapleford T. & Wiggins, G. (1998) Real-Time Music Generation for a Virtual Environment. Proceedings of ECAI-98 Workshop on AI/Alife and Entertainment, August 24, 1998, Brighton.

[26] Sack, W. (1993). Coding News And Popular Culture. In The International Joint Conference on Artificial Intelligence (IJCA93) Workshop on Models of Teaching and Models of Learning. Chambery, Savoie, France.

[27] Sundaram, H., Xie, L. and Chang, S.-F. (2002). *A utility framework for the automatic generation of audiovisual skims*, ACM Multimedia 2002, Juan-les-Pins, France, ACM Press, 189-198, Dec. 2002.

[28] Sundaram, H. and Rikakis, T. (2003). *An Introduction to Experiential Systems*. Arts Media and Engineering Center, ASU, AME-2003-01, 2003.

[29] Swartout W. and Lent, M.v. (2003). *Making a game of system design.* Communications of the ACM **46**(7): 32 - 39.

[30] TALC (1999). http://www.de.ibm.com/ide/solutions/dmsc/

[31] Tonomura, Y., Akutsu, A., Taniguchi, Y., & Suzuki, G. (1994). Structured Video Computing. *IEEE MultiMedia*, 1(3), 34 - 43.

[32] Wold, E., Blum, T., Keislar, D. & Wheaton, J.(1996). Content-Based Classification, Search, and Retrieval of Audio. IEEE Multimedia Magazine, Vol.3, No. 3, pp. 27 – 36, Fall 1996.