Intention-Driven Screenography

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Abstract: The design and reification of Web Information Systems is a complex task, for which many integrated development methods have been proposed. While all these methods ultimately lead to the construction of web pages, very little attention is paid to the layout of these pages. The work report in this paper amalgamates knowledge from art, cognitive psychology and scenography in an attempt to systematise WIS layout and thus to complement development methods with this respect. We discuss principles and rules for page layout that originate from knowledge of visual perception and communication, and then investigate how layout can support the intentions associated with the WIS. This amounts to guidelines for partitioning pages and using layout objects, colour, light and texture to obtain rhythm, contrast and perspective as the carriers for web page comprehension.

1 Introduction

A Web Information System (WIS) is an information system that is made accessible via the world-wide web. Such systems can be of any size, but the primary focus of research in this area is on large-scale systems that require the support of database technology for the content and are used by an unlimited number of users. Consequently, the number of web pages that are needed to present a WIS to its users is very high, and permanent changes to these pages have to be accounted for. Therefore, the design and reification of such systems cannot be left to "HTML-hackers". It has become subject to various development methods such as OOHDM [SR98], WebML [CFB+03], WIS co-design [ST05a, ST05b], HERA [HBFV03], WSDM [DL98] and others, and also UML has been adapted to support WISs [Con03, LHSG02].
These methods differ in many respects, and we do not intend to discuss these differences here. However, whatever method is used, it finally boils down to the writing or generation of web pages. So, whatever sophistication has been achieved through the method, a poor layout of the pages can easily destroy it. Nonetheless, astoundingly little effort has been put into WIS layout. It may be argued that layout is the realm of HCI techniques [BGB98, Car91, Joh97, Val82], but then general HCI techniques are not coupled with spe-

cific development methods, and a lot of the HCI ideas have to be taken into consideration already during WIS design, even at a very high level of abstraction. For instance, the partitioning of pages and colour schemata are linked to the strategic decision on the desired ambience of the WIS as emphasised in [MST05].

Currently, WIS designers are mainly involved in modelling and implementation, while layout is not overly emphasised. However, late consideration of graphical issues may result in inflexibility, and cause problems for extension and change management. Our aim is to support the systematic and early involvement of layout and playout, for which we develop an approach to *screenography* , which adopts and generalises dramaturgy and scenography. Scenography has its roots in theatre, film and television, i.e. outside the web area, and contains the composition of action space, plot and dramaturgy. Dramaturgy controls the sequence of scenes and determines the composition of information. Our claim is to show that WIS layout also requires scenography and dramaturgy to facilitate the understanding and memorisation of content, and to support orientation within the WIS. Screenography aims at providing interfaces of high utility that can be used by any user depending on his/her intentions and tasks. So, we base screenography on a characterisation of tasks, intentions, and specific characteristics of the users, provided by means of user profiles and portfolios. Intentions and tasks determine a user's expectations and interests; specific characteristics influence the patience in dealing with the WIS. As WISs are to provide needed services, the users' real needs and life stories have to be specified. We do this on the basis of life cases that generalise, combine, extend and formalise business use cases.

Screenography captures the *layout* and *playout* of WISs. Layout addresses the graphical design of pages in liaison with content to be conveyed and functionality to be provided by the WIS; it supports users depending on their profile. Playout is based on the story specification, the task portfolio of users, and the contexts of the WIS and its users.

The rationale of our work is to complement the WIS codesign method [ST05a] with a systematic approach to WIS layout that is grounded in knowledge from art, cognitive psychology and scenography. In order to do so we start from a general architecture that determines the WIS development needs. On these grounds we refine intentions and use them to specify user profiles and portfolios [ST06a]. In Section 3 the screenography development process is described in detail. We start with the atmosphere that determines the global ambience type. Next we define patterns and refine them to grids that are used to partition the screen and reify the ambience through appropriate colour schemes [MST05]. In Section 4 we discuss cognitive aspects of screenography. As known from art, photography and scenography the attraction of an observer is influenced by rhythm, contrast and perspective, so we have to use the layout elements in a way that supports the desired effects and directs the attention of the users. We concentrate on layout aspects. Cognitive aspects for playout may be considered in a similar way, but are omitted due to space limitations. Finally, in Section 5 we present a brief application case study, in which we discuss improvements of websites originating from screenography.

This paper introduces structural and cognitive concepts in detail. The intention behind structural concepts of screenography has been sketched in [MNST07]. Open research issues concern dimensions of web information systems such as representation advanced functionality and of highly structured content.

2 Development Prerequisites

A prerequisite of screenography is the analysis of a WIS on a high level of abstraction. So, we have to consider the intentions associated with the WIS, and characterise expected users. This is captured by a storyboard that specifies who will use the system, in which way, for which tasks, and for which intentions. The motivation of user for WIS use is explicitly specified through four facets of intentions: *purpose* (aims or objectives), *intents* (targets or objects), *time* (design, end or occasion) and *representation* (atmosphere or metaphors). Roughly speaking, the first facet represents the 'what', the second the 'how' and the third the 'when' of an intention. Details of these facets were presented in [ST06a].

2.1 Development Architecture.

The Seeheim model for user interface management systems (UIMS) [Gre85] separates the presentation from the application components. Consequently, the development steps regarding these components are separated, too.

The *application* component distinguishes levels for requirement prescription, specification and implementation. However, for the *presentation* component only the specification and implementation level are dealt with thoroughly at present. Nevertheless, the requirement level is also important for the presentation component. At this level we define the intention to be supported by the presentation and characterise the WIS users. For instance, we may define the ambience of a decoration to be colour-independent, because the perception and impression of colours depends on capabilities of users as well as cultural and religious views. On the specification level these global definitions acting as guiding conditions.

2.2 User Models.

User modelling is based on the specification of *user profiles* that address the characterisation of the users, and the specification of *user portfolios* that describe the users' tasks and their involvement and collaboration on the basis of the mission of the WIS [ST06b].

To characterise the users of a WIS we distinguish between *education*, *work* and *personality* profiles. The education profile contains properties users can obtain by education or training. Capabilities and application knowledge as a result of educational activities are also suitable for this profile. Properties will assigned to the work profile, if they can be associated with task solving knowledge and skills in the application area, i.e. task expertise and experience as well as system experience. Another part of a work profile is the interaction profile of a user, which is determined by his frequency, intensity and style of utilisation of the WIS. The personality profile characterises the general properties and preferences of a user. General properties are the status in the enterprise, community, etc., and the psychological and sensory properties like hearing, motoric control, information processing and anxiety.

A portfolio is determined by responsibilities and is based on a number of targets. Therefore, the actor portfolio (referring to *actors* as groups of users with similar behaviour) within an application is based on a set of tasks assigned to or intended by an actor and for which s/he has the authority and control, and a description of involvement within the task solution [ST06b]. A *task* as a piece of work is characterised by a problem statement, initial and target states, collaboration and presupposed profiles, auxiliary conditions and means for task completion. Tasks may consists of subtasks. Moreover, the task execution model defines what, when, how, by whom and with which data a task can be accomplished. To classify tasks it's possible to use existing task models, e.g. Concurrent Task Tree (CTT) or Task Object Oriented Description (TOOD). The result of executing a task should present the final state as well as the satisfaction of target conditions.

2.3 Life Cases.

For task completion users need the right kind of data, at the right time, in the right granularity and format, unabridged and within the frame agreed upon in advance. Moreover, users are bound by their ability to verbalise and digest data, and their habits, practices, and cultural environment. To avoid intellectual overburdening of users we observe real applications before the system development leading to *life cases*. Life cases help closing the pragmatic gap between intentions and storyboarding. Syntax and semantics of life cases have already been well explored in [ST06a].

2.4 Demands for Presentation Development.

Intention, user and life case modelling are very important for screenography. For instance, for developing a satisfactory WIS atmosphere we have to consider the representation facet of the intention, which defines the ambience the presentation should have. It depends on the application area of the WIS and the preferences of the user. The main challenge is the heterogeneity of web clients. Therefore, we specify the atmosphere already on a high level of abstraction. In this area some work has been done and allows the designer to specify device independent the appearance of interaction elements. Examples are UIML (User Interface Modelling Language), AUIML (Abstract UIML), and XUL (Xml User-interface Language). Particularly this approaches developed to realise the functionality aspects.

3 Essential of Screenography

Screenography extends web application engineering by scenographic and dramaturgic aspects and intends to support the interaction between system and user. Screenography aims at an individualised, decorated playout in consideration of intention, user profiles and portfolios, provider aims, context, equipment, functionality and the storyline progress.

3.1 Atmosphere

Defining the atmosphere is the first step of presentation development and a part of intention specification. Due to its definition on a high level of abstraction the atmosphere is independent of equipment features. The reification through page layout and the sufficiency of the available equipment to play out a specific atmosphere will be checked on a lower level. The atmosphere can be described by the ambience of the presentation, which is determined by parameters such as shapes, material, illumination, and colour schema. Further, visual perception is always affected by the current mood and emotions of a viewer.
According to [Mor06] we distinguish the ambience-types *powerful*, in the sense of dramatic art and vitality, *romantic*, in the sense of romance and passion, *elegant*, in the sense of seriousness and dispassion, *refreshing*, in the sense of ease and transparency, *balanced*, in the sense of harmony and balance, and *energetic*, in the sense of phantasm and energy. Figure 1 presents some ambience examples. It shows background facets of the same application, in this case varying only by colour. The colour choice goes back to Goethe [Goe10] and Itten [Itt61]. Each facet consists of 3 colours, a three colour chord.

Figure 1: Facets of the same application: refreshing, energetic, romantic ambience

3.2 Layout Patterns

After the atmosphere, we have to specify layout patterns considering the prerequisites. Patterns are a powerful conceptual framework for building compelling, effective, and easy-to-use websites [vDLH02]. A pattern consists of visual and functional building blocks. According to [MST05] the functional building blocks realise the access to the presented content and order these. The visual building blocks are important for perception and need to consider the *colouring* with respect to functionality and aesthetics, the *perspective perception* of the whole screen, and the *visual alignment* and partitioning of the screen.

The colouring aspect includes the colour schema development on the basis of the specified atmosphere. Therefore, we have to consider the emotions a user usually associates with colours. The effect of colours can be warm, cool, cold, intensive, hot, light, dark, etc. A user's perception is also influenced by cultural aspects and age. According to [Mor06] the basis of a colour schema can be a colour chord consisting of n colours ($n \in \{2, 3, 4, 6\}$) that form a regular polygon in the CMY-based colour circle. The colour chords can be complemented to a *quality contrast* [Itt61] by changing the saturation.

By using any kind of perspective it is possible to realise three dimensional decorations. The perspective aspect of a pattern is mainly determined by the colour schema. In particular,

we have to consider the effect of the colours, because the objects coloured by warm colours appear closer than those in cold colours. Warm colours are assigned to light, while cold colours are assigned to shadow.

The visual alignment is based on a tiling of the screen as a two-dimensional surface. In general, we divide the horizontal and vertical axes using grid points $x_{min} = x_0 < x_1 < ... < x_m = x_{max}$ and $y_{min} = y_0 < y_1 < ... < y_n = y_{max}$. A tile is defined by a rectangular region $[x_i, x_j] \times [y_k, y_\ell]$. Then we partition the whole screen into tiles. A very common tiling is obtained by using just 4 horizontal grid points $x_0 < x_1 < x_2 < x_3$, and only 3 vertical grid points $y_0 < y_1 < y_2$. Then we can define four tiles

$$\text{up} = [x_0, x_3] \times [y_1, y_2] \qquad \text{left} = [x_0, x_1] \times [y_0, y_1]$$
$$\text{middle} = [x_1, x_2] \times [y_0, y_1] \qquad \text{right} = [x_2, x_3] \times [y_0, y_1]$$

Usually, the "up" tile is used for some menu bar, the "left" tile for navigation links, the "middle" tile for major content and the "right" tile for side options.

3.3 Grid Geometry

Grids were adapted from (conventional) graphic design and used for organising page layouts, e.g. newspapers, magazines and other documents [vDLH02]. The tiling described above is a very common but simple grid that only divides rows and columns, without any other restrictions. More sophisticatedly, the size of visual building blocks can follow a rhythmic structure that can be expressed by a sequence of positive integers. Then an observer perceives larger tiles of a sequence as being more important, in particular, if the sequence shows a monotonic pattern.

Due to its overwhelming use in art and architecture over centuries we are particularly interested in the Fibonacci sequence, which is defined by the recurrence $f_{n+2} = f_n + f_{n+1}$ with the starting values $f_1 = f_2 = 1$. This gives the well-known sequence 1,1,2,3,5,8,13,... It also gives rise to the *number of golden section*, which played an important role in art and architecture and appears naturally in nature.

Figure 2 illustrates the visual flags model as a simple use of Fibonacci sequence. In fact it dates back to Leonardo da Vinci and orders sections according to some functional criteria. In this example the Fibonacci numbers (multiplied with a scaling constant) are used as horizontal grid points.

Figure 2: Rhythmic structure of visual building blocks (grid tiles)

Another use of the Fibonacci sequence is to place squares with increasing side length f_i along a spiral as shown in the lower part of Figure 3. In doing so we obtain a very

nice tiling of the screen (*golden square*), in which the proportions of the square tiles are determined by the Fibonacci sequence. By combining with the visual flags we realise the so-called *Fibonacci grid model* (Figure 3).

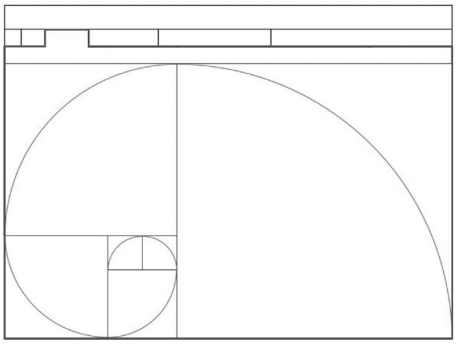

Figure 3: The Fibonacci grid model

If each tile is associated with a colour of a well-chosen colour schema, this enables desired atmospheric effects as specified in the strategic WIS model [MST05]. The thesis [Mor06] shows this combination of the Fibonacci grid with various colour schemata in different web application projects.

4 Cognitive Aspects of Screenography for Layout

Screenography bases screen and particularly WIS layout on cognitive psychology. The layout of WIS pages contains *functional elements* such as icons for navigation and functions, and *visual elements* for presentation of texts based on script and colour and of pictures and structures in different displays. The designed screen is regarded as a structured composition of different elements and is defined as screen layout. Enhanced descriptions how to design the user interface was depicted through Norman [Nor88] and Shneiderman [SP04]. Screenography uses three kinds of principles taken from cognitive psychology: principles of *visual communication*, of *visual cognition*, and of *visual design*.

4.1 Principles of Visual Communication

A clear and well-defined design of a screen layout helps to grasp and to understand the content and enables to select and to access the information. It is a precondition for the successful communication. Visual communication is based on the exchange of visual codes with special meanings. Sender and recipient agree on the meaning of the communication utterances which are typically expressions in a visual language adopted and understood by both partners. A sophisticated specification of visual communication is one precondition for interaction support. It consists of three components:

- *Vision* supports users depending on their physical and physiological properties. Users are used and are limited to certain colouring schemata, to different presentation styles and to different reception styles.
- *Cognition* is based on the physiological and psychological abilities and skills of users. We must take into consideration the approach users take while reading content and using functionality.
- *Processing and memorising characteristics* are based on the psychological ability to read, integrate, and reason about content provided by a page, and to memorise main parts of the content – these vary a lot among users.

Visual communication starts with separating the visual entities on the screen into elementary layout elements. This separation is an analytical process. Visual elements are compared, processed and memorised after recognising them. The scenario for visual communication can be used for developing the layout, i.e. we reverse the order of visual communication. First, visual elements that should be memorised are developed and integrated with the content and functionality necessary for their recognition. Next, these elements are integrated into a draft of the layout. Finally, adornments, presentations, and placements are added.

4.2 Principles of Visual Cognition

Principles of visual cognition and visual communication refer to *ordering*, *effect* delivery, and *visualisation*. Ordering is based on an arrangement according to the reading direction and on design according to foreground and background relation. The effect uses background for formation of thematic and optical frame, and schemes of colours and structures. Visualisation is influenced by visual design features such as colour, contrast, composition, overlapping, and cuts [Goe10, Itt61].

We can use a number of principles of visual cognition in screenography. Users are limited by their time, attention, scope, and task portfolio. These limitations must be taken into consideration for layout and playout development. We distinguish four principles that should be preserved:

- The principle of *organisation* requires that screens must be based on a simple, clear and consistent structure. The simplicity, clearness and consistency depends on the cultural background of users.
- The principle of *economy* requires that users should spend minimal effort for recognition and reasoning on visual elements. This principle is supported by minimisation of the set of tools. Users increase their effectiveness of recognition and reasoning.
- The principle of *communication* considers the abilities and the skills of users. This principle is well known from didactics, where content and functionality are adopted to the capacity of users.

- Screen design *standards* allow the user to reuse their previous recognition and reasoning results. These standards define the organisation and design of visual elements.

4.3 Principles of Visual Design

We use a number of principles of visual design in screenography:

- The *optical vicinity* principle requires that elements are arranged close to each other, if they are related.
- The *similarity* principle is based on human cognition according to which elements of similar shape are identified as a visual unit.
- *Closeness* is based on the human visualisation according to which objects need to have a closed shape. Otherwise, missing elements are added.
- The *symmetry* principle uses units that consist of symmetrically assembled elements. Symmetric and asymmetric structures are visualised in the foreground, whereas all other asymmetric elements are taken to the background.
- The *conciseness* principle uses visualisation with simplified and consistent organisation of visual screen elements.
- The *reading direction* principle optically composes static elements (pictures, texts, icons) by the given reading direction. This leads to a shift of the optical focus. We distinguish between geometrical and optical centre. For instance, the thickness of horizontal lines is optically enhanced. Vertical lines seem to be thinner.

These principles help to organise the elements within a page in a way that correspond to human perception. Elements are always recognised within their context. Their value differs *based on their syntax*, i.e. the formal and aesthetic value, *based on semantics*, i.e. content and objective value, and *based on pragmatics*, i.e. ethic and applicability value.

5 Application of Screenography: Case Study

In this chapter we demonstrate the potential of the screenography approach, using a B2C example. This example indicates how we achieve an adaptive playout, considering the intention of the WIS, user profile and portfolio as well as existing lifecases. In general this B2C-WIS offers company and product informations can described by following information pattern (who-what-to_whom-what_activity):

$$(company)^{information\_on\_products}2(visitor, purchaser)^{inform,purchase}$$

In our example acts a small business, producing hand-made collections of wood-figures. The aim of company is to distribute the collections via the web. The content per page shouldn't be oversized, because the carefully selected product choice and important role of quality. Wood as basic material of all products of the company should be considered. Considering the business philosophy, the presentation style have to be traditional and folksy. The ambience type 'balanced' implies that.
Before defining the 'balanced'-colours we have to characterise the user. That's necessary because the perception and impression of colours depends on capabilities of a user and e.g. cultural as well as religious views. Moreover the age of a user plays an important role. In our example the user is a married european man in his thirties, without special colour preferences. The user prefers a conservative design resp. a adequate composition. In conjunction with the intentions we deduce a suitable colour chord illustrated in fig. 4.

Figure 4: colour chord - ambience type 'balanced'

Subsequent to the atmosphere determining, we have to choose a pattern. Pattern consist of three parts: visual alignment, colourising and perspective perception (section 3.2). Visual alignment is influenced by lifecases, perspective requirements and the user profile as well as main properties and targets. For instance the content size and the navigation structure and depth influence the tiling. The example user acts deliberate and target oriented. He has no handicaps but don't prefer very small interaction elements. We consider lifecases to achieve the best possible orientation the user should have during the acting progress. Thus it's possible to choose the Fibonacci grid for representation, illustrated in figure 3.
The way of assigning the colours to the pattern mainly depends on chosen ambience type. The coloured pattern is illustrated in figure 5.

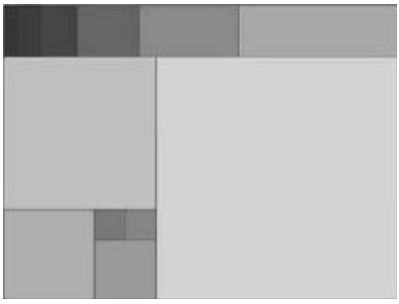

Figure 5: Fibonacci grid model with ambience type 'balanced'

The last step integrates the content. The representation of content considers user and provider preferences. For instance an adequate picture-size to present details of the hand-made products. User portfolio and lifecases influence the story flow. Furthermore, depending on tasks they have influence in content representation, e.g. the type of progress. The result of the development process is illustrated in figure 6.

Figure 6: Sample page for 'balanced' atmosphere

6 Conclusion

This paper presented *screenography*, a novel approach to layout and playout of Web Information Systems (WISs). Screenography transfers the accumulated knowledge in scenography and dramaturgy from its origins in theatre, film and television to the web area thereby exploiting results from creative arts, cognitive psychology, and stage scenography. The rationale behind our work is that layout and playout are not merely activities that start, when the major system design has been completed, but must be treated as integral part of WIS development from the very beginning; a poor layout can nullify all sophisticated modelling work, because the layout is the ultimate carrier of information in a WIS.
Screenography is tightly intertwined with storyboarding, the method for WIS usage modelling on a high level of abstraction [ST05b]. It contributes to page partitioning and colour scheme definition in a holistic way.

Screenography is an attempt to turn WIS layout and playout from an art into a craft, i.e. it aims at enabling WIS designers to engineer systems that by virtue of their presentation are conceived as exceeding the expectations of its users. The work presented in this paper is a first step in this direction, yet still much more has to be done to extract knowledge from arts and bring it into a form that can be used by WIS engineers.

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