Turning me on, turning me off

More patterns for a pattern language of interactive information graphics

Christian Kohls, c.kohls@iwm-kmrc.de
Knowledge Media Resarch Centre, Tuebingen

Tobias Windbrake, wb@fh-wedel.de
University of Applied Sciences Wedel, Wedel

Abstract

Interactive graphics are an effective way of communication and information delivery, especially for complex domains. However, domain experts are rarely aware of the potentials of interactive visual displays and which interaction principles can be in charge for communication and teaching purposes. In this paper we extend a pattern language for interactive information graphics and present four patterns. These patterns are all variations of buttons that can switch between two visual states. Each pattern describes the consequences and special fields of application related to the chosen button type in an educational setting.

Target Group

The language captures expertise about interactive graphics and focuses on the educational benefits gained by each form of interaction. The primary target group are developers of multimedia learning materials – for both, classroom and online sessions. The language can be particularly useful for:

Educators who want to enhance their course materials with interactive graphics.
Teachers who want to use interactive content in their classroom lessons.
Editors and designers of rich online learning materials.
Information designers who want to enrich websites with interactive diagrams.
Exhibitors who want to design interactive information kiosks in museums or visitor centres.
Users of interactive displays.
Programmers who want to learn when and why an interactive screen adds value to content presentation.
Project teams who need a common language to plan their development of materials, e.g. course designers can unambiguously communicate to developers.

The goal is to illustrate what forms of interactive graphics are used in today’s multimedia materials and how and when they can be used beneficial in educational contexts.

About the patterns

Interactive graphics certainly helps to analyze, understand and communicate models, concepts and data [Rie90], [SM00], [May01] if applied appropriately. Each pattern explicitly names situations where to use it and gives a rationale why it can support the communication process. With respect to the aimed target group of this pattern collection, the technological aspects of the pattern descriptions should be low-threshold. There is no implementation section in the documented patterns because educators, teachers and trainers are not likely to implement the patterns in program code. Skilled programmers on the other hand will profit more from understanding the pedagogical values than seeing rather trivial example codes. Another issue is that implementations in different authoring tools are very idiomatic. Thus, explaining the implementation in one tool would give no insights into the options other authoring tools may offer. Fortunately, multimedia authoring tools recently started to offer templates, wizards or objects to instantiate the patterns without programming. The major goal of this language is to inform about the potentials, benefits and limitations of interactive graphics. The proper use of interactive graphics is another issue. Using an inappropriate form of interaction can do harm to the process of learning and understanding. Therefore, this pattern collection is also a guide to choose the right formats for the tasks at hand.

The patterns presented in this paper are different variations of graphic buttons. Buttons are common widgets in user interface design. The perspective taken in the present patterns is to discuss the educational use of buttons in interactive graphics. One can also learn about the consequences and special fields of application depending on the special type of button that is chosen. One of the major differences to other descriptions of buttons is that in the given examples the visual form of the buttons is different from the standard box layouts. In educational illustrations any graphical form, shape, text, area or image can be used as a button.

The pattern collection for interactive information graphics relates or overlaps with languages for human computer interaction [Ba97], [Bor01], [GLC01], [MJ98], [Tid05], [Wel05], the design of websites [WV03], [Sc05], [Mah06], [MLC05], [DLH04] and patterns for education and e-learning [PPP], [VW04], [ND05]. The patterns that can be found in this paper are all well-known human-computer-interaction patterns (and are described in [Tid05], [Wel05]). What is new to the patterns is the view of how to use these interaction forms in an educational contexts and which pedagogical challenges are solved by the patterns. The patterns presented are a prosecution of a pattern collection that has been presented on previous PLoPs. As a feedback from the various workshops, the pattern descriptions have become highly visual.

PLoP 2006	EuroPLoP 2007	PLoP 2007	EuroPLoP 2008
Optimize Object Perception Dynamic Labelling Switch Between Object States	Transport Objects Synchronize Object Motion Drag Restriction	Active Areas (Hot Areas) Activator No-Go-Areas Sandbox	On/Off Button Rollover Button Radio Button Information Display

Note that the patterns TOGGLE BUTTON, ROLLOVER BUTTON, RADIO BUTTON, and INFORMATION DISPLAY are differentiations of the SWITCH BETWEEN OBJECT STATES pattern presented at PLoP 2006 [KW06]. The SWITCH BETWEEN OBJECT STATES focussed on technical similarities. On the code level the four patterns presented in this paper are almost identical, i.e. in Java the difference between a TOGGLE and a ROLLOVER BUTTON is usually just in which method of the event interface the property is changed. However, end users perceive mouse over and mouse clicks quite differently in terms of usability and semantics. In an experimental setting we have asked teacher students to categorize interactive graphics based on some patterns of this pattern language [KU09]. For all students the event trigger (mouse over or mouse click) was a discriminating feature.

Also note that DYNAMIC LABELLING is a pattern of a higher level focussing on educational function only rather than the interaction form. A DYNAMIC LABEL can be implemented by all of the patterns present in this paper and by ACTIVE AREAS and ACTIVATORS as well.

Different buttons for different purposes

Now, which button type is the best for you? It depends on the context and type of information you intend to provide. What you can do with each type of button you will find in the “What can I do with this interaction form?” sections which list typical scenarios and applications. Every button type has its own benefits and liabilities. To select multiple elements simultaneously one can use Toggle buttons e or several independent groups of Radio Buttons. An Toggle Button lets the user decide at which time to switch each element individually. While this adds more freedom to the user, it can also result in messed up screens, e.g. too many added elements increases complexity, pop-ups hide other information or the whole graphic alters to an unsatisfactory state. To ensure that graphic elements automatically switch back to their original states, Rollover and Radio Buttons are a good choice. Rollovers are more intuitive, give faster access to extra information and implicitly indicate which element is currently inspected while Radio Buttons keep selected information permanently available and do not block the mouse pointer for other tasks. Toggle Buttons can build up graphics step-by-step whereas the other interaction forms allow transferring a focus step-by-step.

Toggle, Rollover, and Radio Buttons all alter a base graphic. That way, newly added information is integrated into the graphic but also hides or overwrites information. In opposition, an Information Display is always spatially separated and does not interfere with the graphic. But it also splits the attention between inspected elements and the explanatory information. Only Information Displays allow defining more than two visual states for an element. The element that shows the state for the Information Display is always distant to the display itself. All other button types allow to be both trigger and output element in one. Which functions are supported by which button type is summarized in the following table:

	Toggle	Rollover	Radio	Info Display (click/rollover)
Selection of multiple elements simultaneously (e.g. to compare or filter objects)	X			
Assigning multiple (>2) visual states to an element				X
Mouse pointer indicates which element is currently inspected		X		- / X
Mouse pointer is available for other tasks (and not stressed for activation)	X		X	X / -
Build up a graphic step by step	X			
Focus on graphic elements step by step		X	X	X
Additional elements do not overlap base information permanently		X	X	X
Additional elements are nearest to base information	X	X	X	
Allows to change components of a graphic	X	X	X	
Added elements and element changes remain persistent until explicitly reset	X		X	X / -
Elements do not need a visual affordance to indicate that they can be clicked		X		- / X
Highlight and focus elements	X	X	X	
Button element (hot area) can be changed itself	X	X	X	
Can be used to replace large components or the complete graphic	X			X
Can be used to replace small components of a graphic	X	X	X	

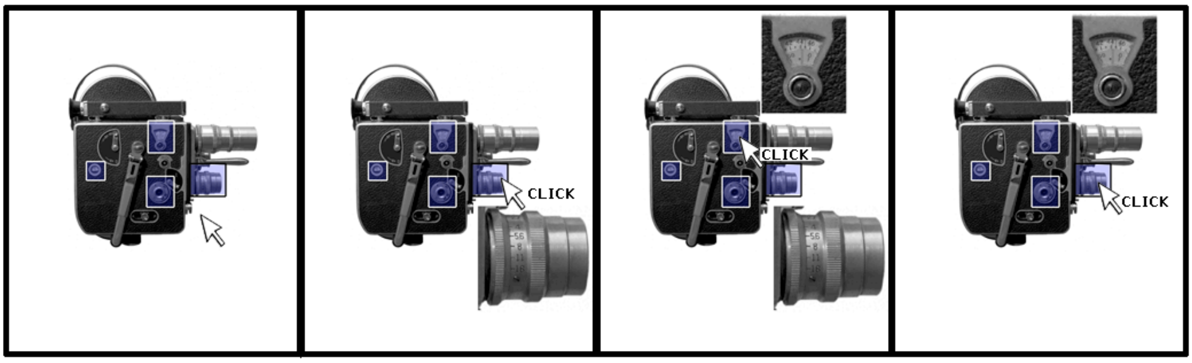
Supports exploration of a graphic	X	X		X
Supports explicit selection of elements	X		X	
No explicit operation required to deactivate an element		X	X	- / X

Toggle Button – ON/OFF Button

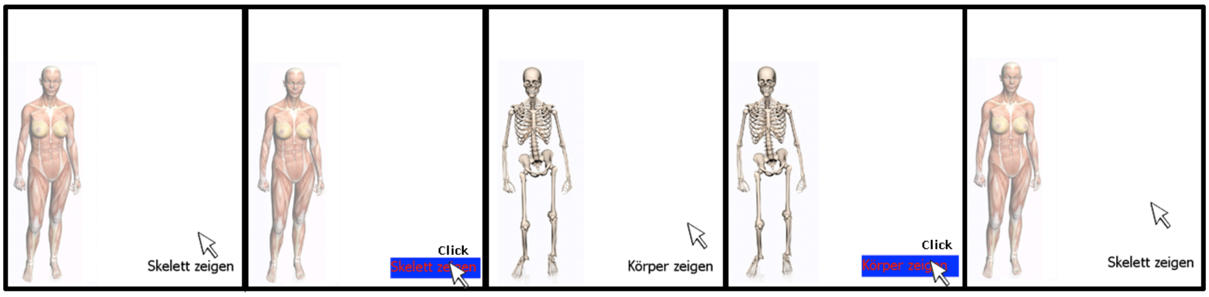
Provide a way to change between two visual states of an element by clicking at it or a separate button.

Examples

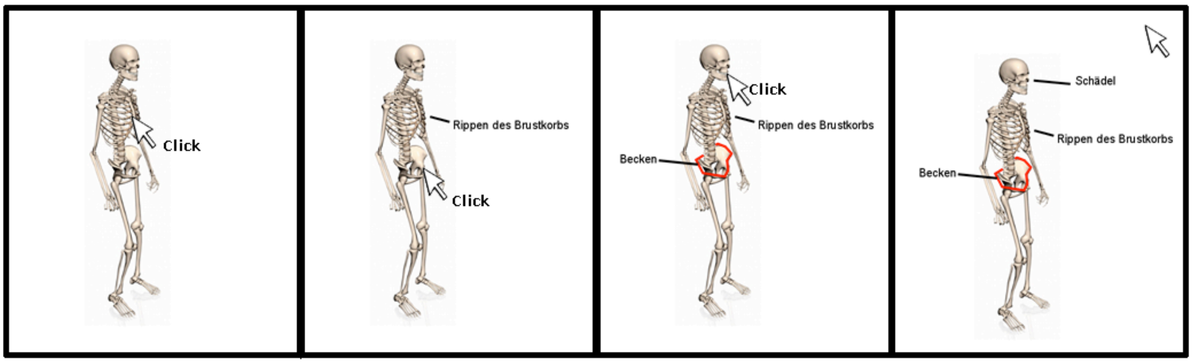
Zoom on Demand: If the user clicks at on of the marked areas, an enlarged illustration pops out. The detailed illustration has to be deactivated explicitly by clicking at the corresponding area for another time.



Switch illustration: The text acts as a button that switches between a medical illustration of muscles or skeleton.



Dynamic labels: By clicking at areas of the skeleton, the labels appear.



Context

For illustrative purposes you are using an information graphic in your classroom or in multimedia materials. The information graphic is very complex and consists of many visual elements (e.g. labels, boxes, parts, connections). Some of the elements might be of a dynamic nature and can change their states (e.g. a light bulb can be on off, water can be frozen or not, an engine can idle or run). Some elements are in themselves very complex and need further explanation or even different kinds of explanations. Adding all these multiple states and multiple explanations makes the graphic even more complex. Yet all the information given is needed and cannot be reduced without loss.

Problem

You cannot leave out elements without losing important information necessary to understand the illustrated subject but at the same time the complexity and amount of information is just too overwhelming and makes it very hard for students to process the given information and focus on relevant aspects.

Forces

Many subjects require complex graphics to illustrate relations and contextual information but huge graphics can be overwhelming and the observer may not know where to start.

Today's presentation tools allow adding information in a predefined sequence step-by-step, however, depending on the subject it may be desirable to add elements in random order.

Adding information allows integrating new elements into the existing knowledge representation but what to do with information that is needed only temporarily?

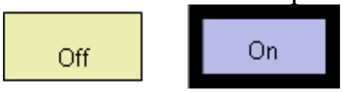
Multiple representations of objects (i.e. to show transformations, causal chains, different viewpoints or levels of detail) can be accessed by navigating to another graphic screen but what if only parts of the graphic should change? How to keep the number of prepared graphics small if different aspects of a graphic can vary independently?

Solution

Add, remove or change elements dynamically in one graphic to reduce its complexity and show elements or their alternative states only when needed.

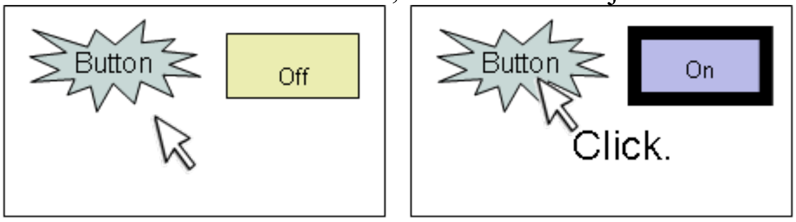
To exactly control when elements change their state from invisible to visible or from inactive to activate or from on to off, define for each alterable element a trigger. The trigger changes the alterable element between two preset states. We shall call these two states ON and OFF.

Each of the states is represented by different visual properties:

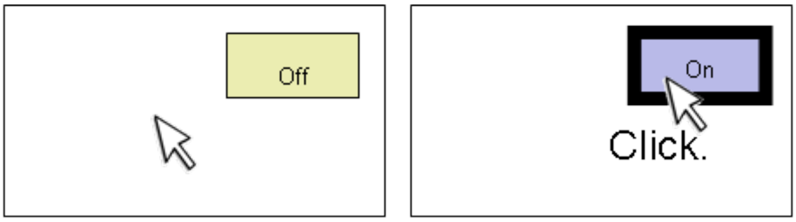


Define an element on the screen as a button that triggers the state change:

If the user clicks on the button, the ON-OFF object switches to the opposite state:

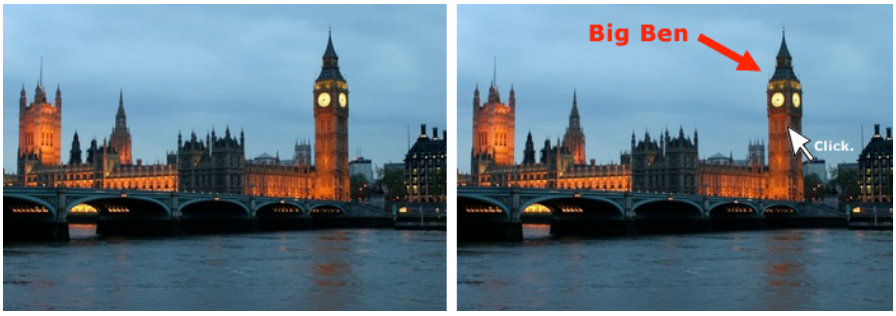


The button can be the ON-OFF element itself. That is, a click on the elemrnz will change its own visual state:

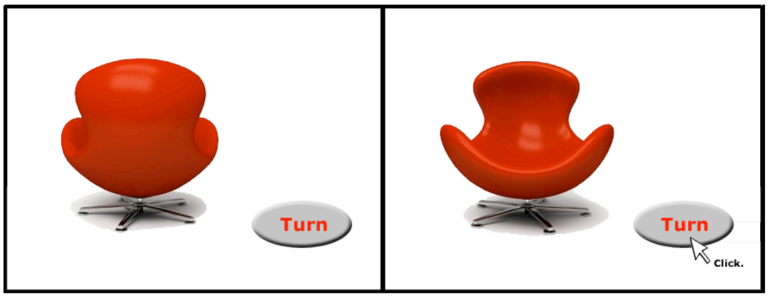


Details

Elements that change their state between visible and invisible overlay an image in the background if they become visible. In this case extra information is added to a base graphic. In the following example, a transparent button element overlays Big Ben. If the user clicks at it, arrow and annotation overlay the picture in the background without changing the picture:



Instead of adding elements, buttons can be used to change elements. In the next example the “Turn”-button changes the image element of the chair:

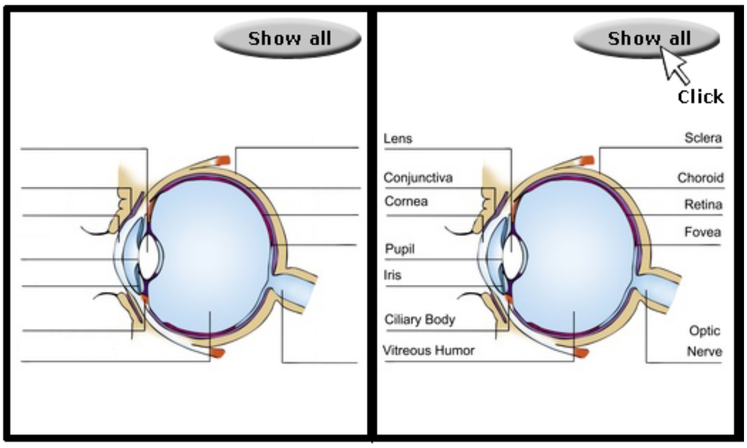


Buttons can be integrated in a larger picture or illustration. By splitting up an image into independent elements, each element can switch between ON/OFF states if required. The next example shows the chair as a changeable element of a picture:

Instead of clicking an extra "Turn" button, the element could be buttons itself:

The great advantage of ON/OFF buttons is that the user has full control over the activation of elements. The order of adding or changing elements is not predefined. Also, the user is free to choose how long an element remains in a chosen state. He can activate any selection of ON/OFF elements whenever he wants and set the complexity of the shown graphic as he wish. Information can be filtered and the combination of activated elements is not preset.

An ON/OFF button can turn multiple elements to ON or OFF in one step:



Other properties that typically change are colour or text. Colour changes can be used to highlight some elements out of a group. Text changes can be used to give different information, e.g. translation of a vocabulary:

Cherry
Kirsche
Click

What can I do with this interaction form?

- Switch on and off additional information on the screen.
- Show pop-up information in small boxes on demand.
- Show the front and the back of an object.
- Switch on and off overlay elements for pictures.
- Switch on and off labels that explain parts of a picture.
- Ask a question and show the answer by clicking at the object.
- Reduce complexity by hiding elements if not needed.
- Adding elements step by step in random order.

Rationale

Adding visual elements on demand reduces the complexity as only the elements currently needed are displayed. Also, it allows building up complex graphics step-by-step and helps to avoid cognitive overload by chunking information [CS91]. Having the user decide which elements should be turned on or off at any time gives maximum control to the user. In general, buttons are graphic user interface elements that can trigger action and display states as well [Tid05]. In the context of educational graphics they switch between two states of elements. Thus, all objects of the world that may be represented by two major states, can be simulated by an ON/OFF button. Switching the states explicitly by a mouse click is a form of direct manipulation [Shn87].

Drawbacks

Each button can only set two states, ON and OFF. Many objects in the real world, however, offer more than two interesting visual states. To assign multiple visuals states to an object, an INFORMATION DISPLAY can be used.

The user has to explicitly turn off an element to deactivate it. In particular, if too many elements are activated simultaneously, an image soon becomes overloaded. RADIO BUTTONS and ROLLOVER buttons automatically turn OFF an activated element for the price of having only one element activated at a time.

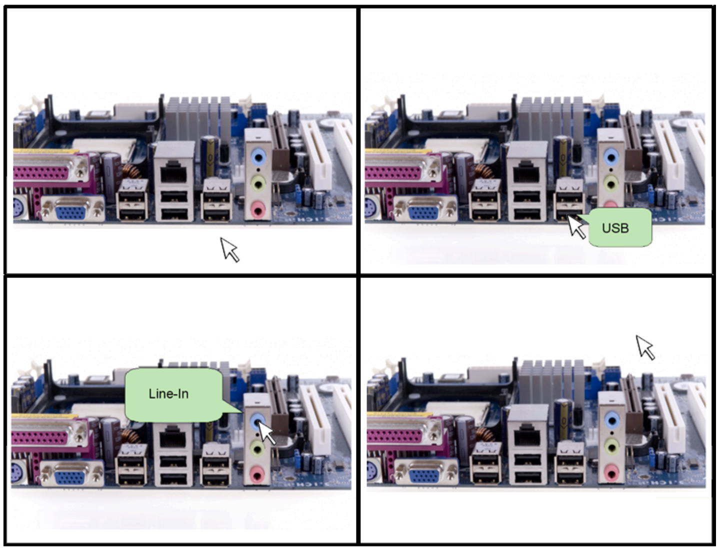
The changeable graphic elements have to be equipped with their own affordances in such a way that the user can understand where he can click.

Rollover Button

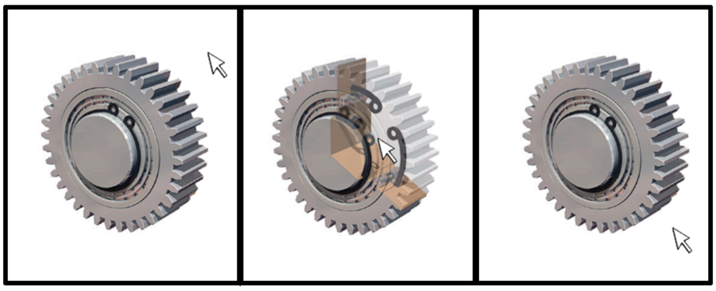
Provide a way to switch between two visual states of an object when the mouse pointer enters a hot area.

Examples

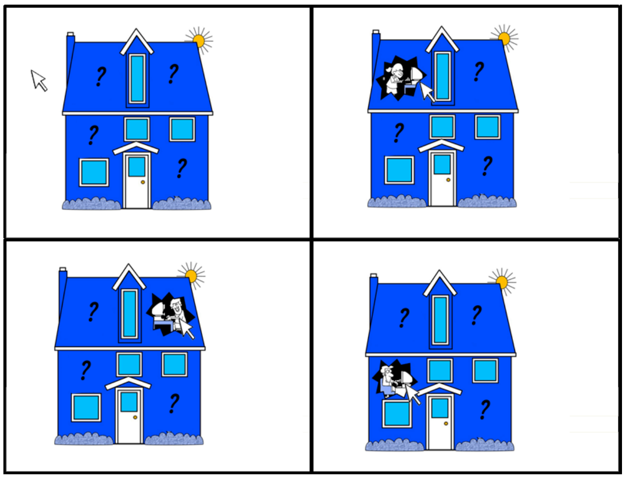
Tips/Hints: If the mouse pointer moves over interesting areas of the image, a text bubble appears. The text in the bubble explains what is shown under the mouse pointer. The text bubbles disappear automatically as the mouse moves on to other interesting areas.



Ghost drawing on demand: If the mouse pointer moves over certain parts of the image, an overlay shows the insights of the object.



Look through walls: If the mouse pointer moves over the question marks, the wall disappears and the user gains insights into the house.



Context

You are using an information graphic that can be explored by your students individually on a laptop or PC. The information graphic consists of many elements and some elements are interrelated (e.g. labels and text are related to objects, elements can be part of the same set, elements can be connected, elements can show different states of the same object). The interrelation between the elements should stand out and it should be clear which elements belong together. The student should be allowed to focus on some elements without losing the context of the whole graphic.

Problem

A huge number of elements makes it hard to recognize element relations and overloads the screen. Elements may interfere each other, hide other elements, or be hard to perceive as separate units.

Forces

Changing a graphic allows exploring given information but how can the user recognize which data s/he is currently focussing on?

To replace graphic elements or to open information pop-ups allows adding details on demand and fading-in further explanations but how can the user efficiently find out which parts of the graphic trigger such changes?

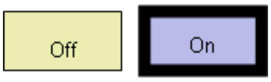
Adapting the given information according to the needs of the user allows for self-paced learning but altering all parts of the graphic can also mess up the illustration. Also, adding more and more information reduces the clearness of the original graphic.

Adding information ad-hoc to provide object specific information avoids split attention effects but the overlay information also hides some parts of the graphic in the background.

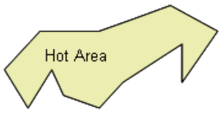
Solution

Add, remove or change elements dynamically by using the mouse pointer as an implicit trigger for element changes. This allows for rapid, user-controlled changes of focussed elements. If the mouse pointer points to a specific element, interrelated elements can change their states (e.g. fade in, highlight or show a different image). Automatically reset all changes if the mouse pointer exits the trigger element to no longer focus the activated element(s).

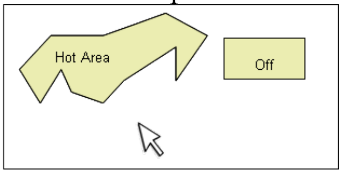
To highlight elements, define for the elements in question two visual states ON and OFF by having some visual properties set differently:



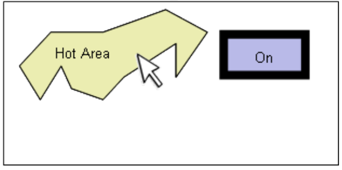
Define an element as a hot area that is sensitive to the mouse pointer:



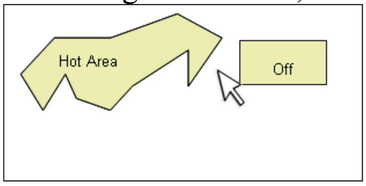
If the mouse pointer is outside the hot area, show the OFF state:



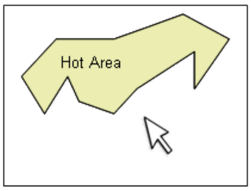
If the mouse pointer is within the hot area, show the ON state:

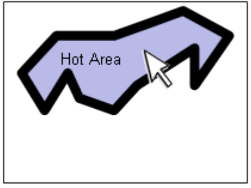


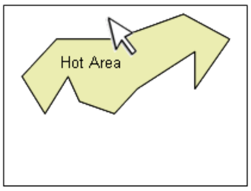
On exiting the hot area, return to the OFF state:



The hot area can be the ON-OFF element itself. That is, if the mouse pointer enters the element it will change its own visual state:







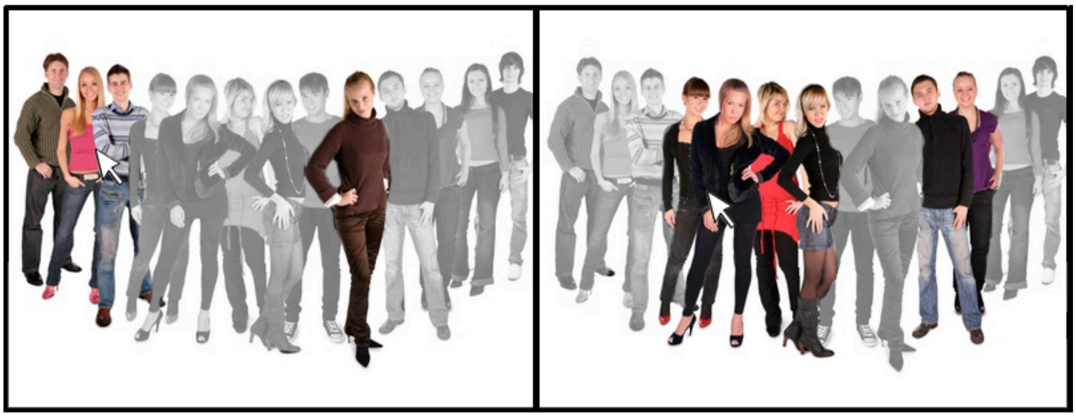
Details

A rollover is a button that automatically turns an elemrnz ON if the mouse pointer enters the hot area element and automatically turns the same object OFF if the mouse pointer exits the hot area element.

Information changes or pops out implicitly without having the user to explicitly click at an element. The later case would require him to know where he can click, while a rollover offers the information more incidentally. Users can explore images intuitively and will immediately recognize where additional information is available. Information is presented rather on-focus than on-demand. If the mouse exits the hot area, the ON/OFF element returns to its visual OFF state. This means that there can be only one element highlighted at a time. This cleans up the screen automatically but also means that information is only temporarily available.

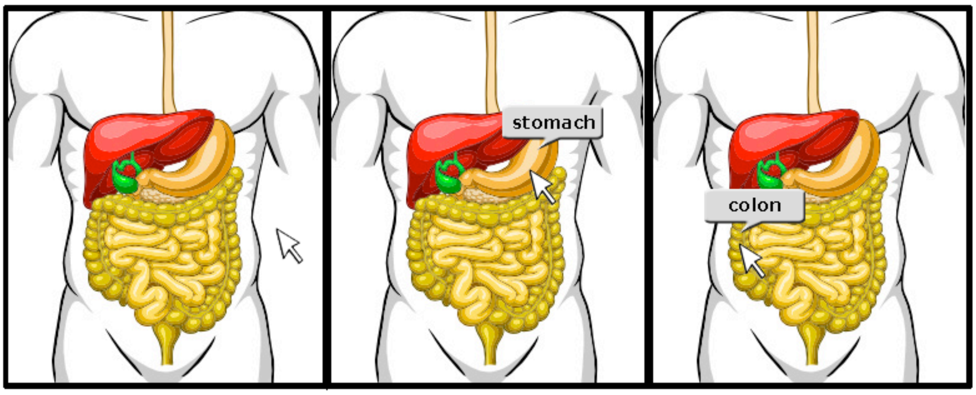
Because the ON state is only temporarily for an element, a roll over can indicate that an element or an area is activated at the moment. It can highlight which element is focussed by the mouse pointer. If elements on the screen offer an affordance for further operations (i.e. clicking at an element or drag the element), the highlighting indicates on which element the mouse pointer would operate.

The transient character of rollover buttons can be useful to highlight related objects on the screen. For example, by moving the mouse pointer over one element of a set, all members of the set could be highlighted. In the next example you see a group photo in which the members of a team are highlighted simultaneously:

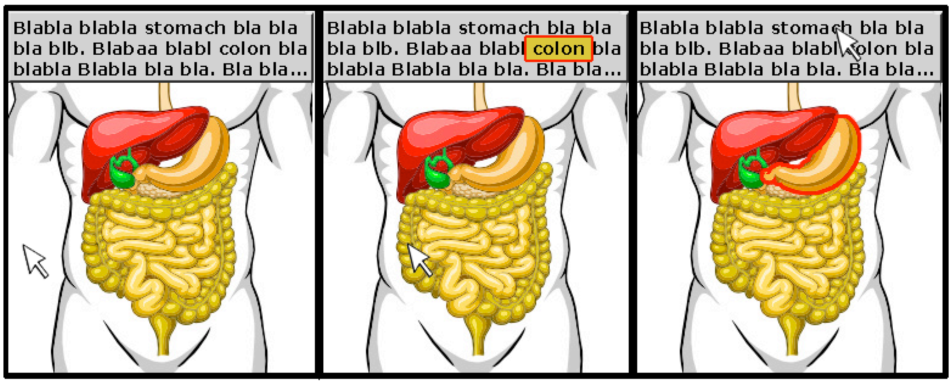


An advantage of an overlay (such as a label or text bubble) is the spatial nearness to the object. Hence, the coherence of base data and faded-in data is optimized. However, overlays are also disturbing because overlays hide data in the background.

A rollover minimizes the area which is hidden because the overlay disappears as soon as the mouse exits the hot area:



To avoid overlapping completely, an INFORMATION DISPLAY can be used for the price of separating text and image. To conserve coherence between an illustration and the text, corresponding words and objects could be highlighted at the same time:


Blabla blabla stomach bla bla bla blb. Blabaa blabl colon bla blabla Blabla bla bla. Bla bla...
Blabla blabla stomach bla bla bla blb. Blabaa blabl colon bla blabla Blabla bla bla. Bla bla...
Blabla blabla stomach bla bla bla blb. Blabaa blabl colon bla blabla Blabla bla bla. Bla bla...

What can I do with this interaction form?

- Highlight related areas or related information on the screen.
- Show or highlight all objects of one class or one set.
- Indicate that an object is activated or that the mouse points at an object that can be activated.
- Highlight the bounds of an object, e.g. highlight where the border of a country runs.
- Dynamically fade in info boxes, windows or text bubbles.
- Provide tool tips.
- Show objects in a different state by activating them by the mouse pointer.

Rationale

Roll-over buttons add and remove additional information automatically to the graphic. Thus, the visual elements are not required to have additional visual affordances [Gib79], because the mouse pointer can explore the graphic by moving over interesting areas. Because no explicit operations (such as mouse clicks) are required, the use of roll-over is self-explaining to the user. Adding information only temporarily will automatically clean up the graphic when the focus is lost. Therefore, information overlays can be integrated into the graphic with only minor disturbance. The advantage is that extra information is close to the visual context it refers to. Hence, the contiguity principle - graphics and corresponding texts should be placed close together – is respected [MM99]. Also, having related objects close together lets the observer perceive them as a unit according to the gestalt law of proximity [Gol89]. By only having one roll-over button activated at a time, an implicit focus is given to direct the attention of the user. As attention is a limited resource, this can help to reduce the cognitive load [CM02]. Confusion about which label belongs to which area is avoided since the mouse pointer establishes an unambiguous point of reference.

Drawbacks

Using the mouse pointer for the activation of elements means that the pointer cannot be used for anything else while activating the specific information. To let information pop out for a longer time period, a RADIO BUTTON is an alternative which also takes care of only having one information unit activated at a time. A RADIO BUTTON, however, is less intuitive as it requires a more explicit user input (mouse clicks).

Some interactive displays, such as touch monitors and some interactive whiteboards, do not recognise mouse motion without pressing the surface. Hence a rollover (which occurs on moving the mouse without pressing the mouse button) will not work. As an option, one can design an ON/OFF button that responds to pressing the mouse button (instead of mouse entering) and releasing the mouse button (instead of mouse exiting).

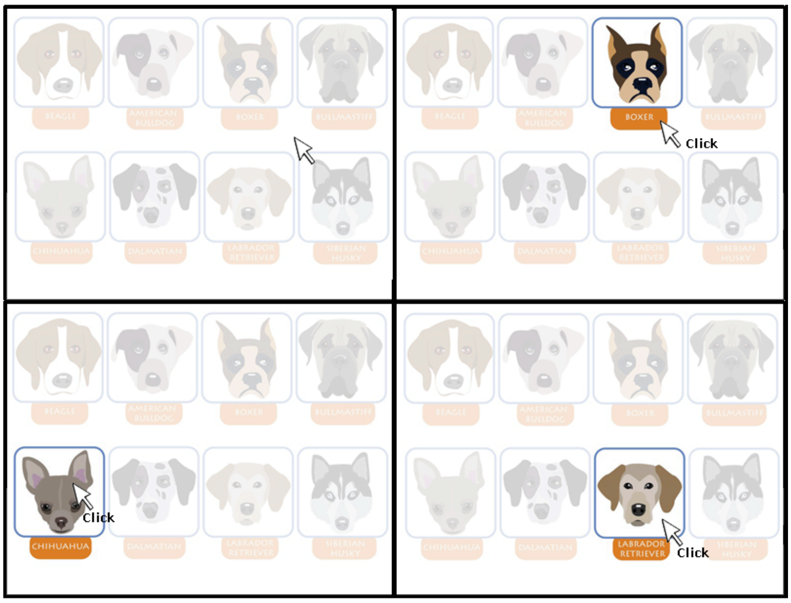
It is not possible to select multiple elements simultaneously (e.g. to compare representations or reduce the number of objects). Since each added information is automatically discarded if the focus is lost, a ROLLOVER can not be used to create complex illustrations step-by-step. To implement such behaviour, use a TOGGLE BUTTON instead.

Radio Button

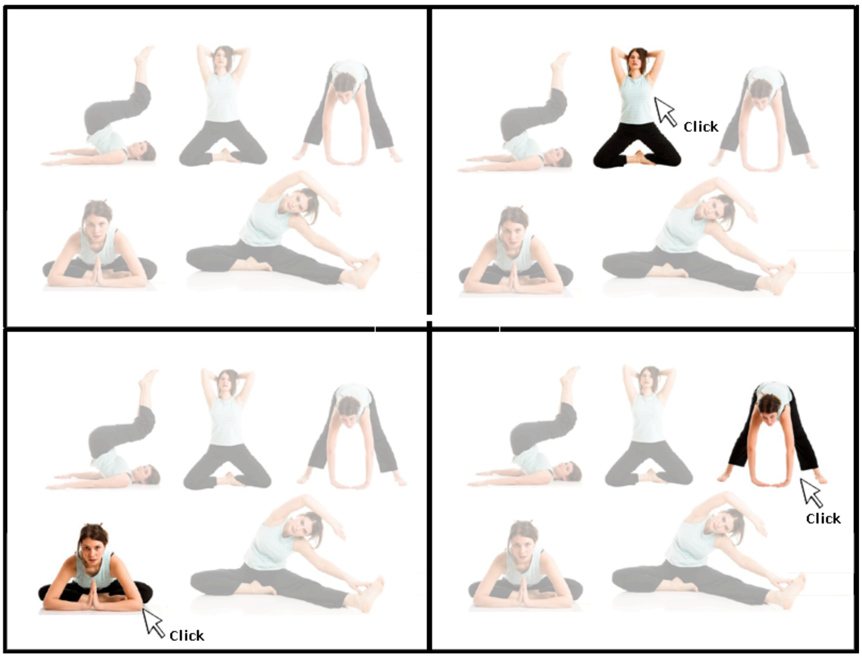
Provide a way to highlight one element out of a group.

Examples

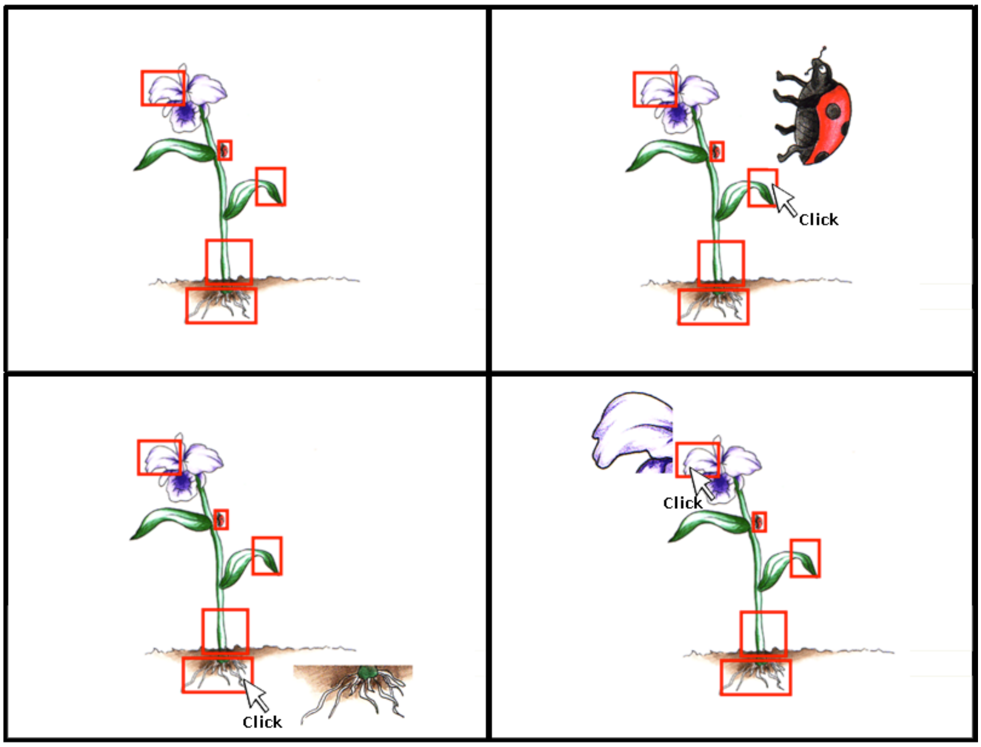
Focus on information. By clicking at one of the dogs, its opacity changes and the user can focus on that information unit. Only one of the information units is highlighted at a time.



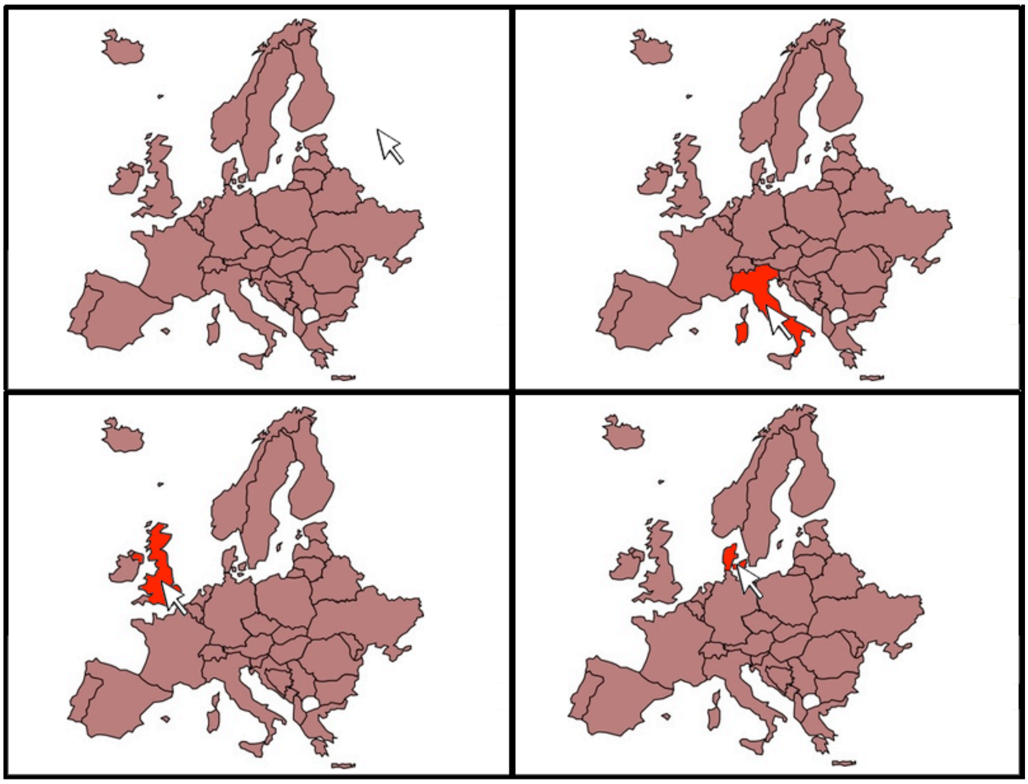
Yoga exercises: One of the exercises is highlighted to show the participants which exercise should be performed next.



Zoom on Demand: If the user clicks at on of the marked areas, an enlarged illustration pops out. Any enlarged illustration shown before disappears. Thus, only one zoom is visible at a time and the attention is directed to only one zoomed detail.



Showing bounds: If the user clicks at any country, the complete area of that country is highlighted. Thus, one can see exactly which parts belong to a country. In particular, this is helpful if the areas are separated.



Context

You are showing a complexly information graphic with distinct elements to your students. In your presentation you are going to focus on some of the elements separately. To assist your audience in paying attention to the element you are talking about it should be easy to find and recognize it.

Problem

In a graphic full of elements it is hard to recognize a specific one and to discriminate it from other objects (e.g. to find the exact position and/or boundaries). While searching for the element the observer is distracted and cannot pay full attention to your talk.

Forces

Adding and changing graphic elements on demand makes an illustration adaptive and flexible but can also mess up the screen or hide important information.

Turning graphic elements on and off allows selecting and filtering the information displayed on the screen but how can one element be selected as a special one? How to focus and highlight one element instead of treating all elements equally? How to ensure that only one object out of a group is activated and shows a special visual state?

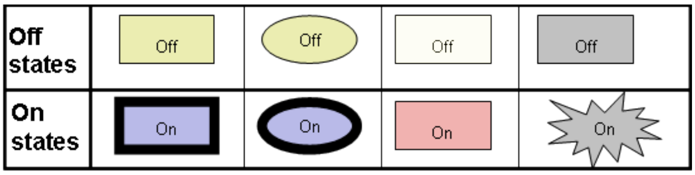
In some graphics one has to avoid that multiple elements are selected simultaneously but users may forget to deselect other elements. Deselecting an element may be inconvenient as it involves extra mouse moves. To deselect an element, the user has to search for the currently activated element on the screen but graphic elements may not provide explicit visual hints which element is currently activated.

Temporarily activating elements or groups of elements could be done by RADIO BUTTONS as well. But if the mouse pointer has to be available for other operations the activation and deactivation of elements must be triggered explicitly and not bind the mouse pointer. TOGGLE BUTTONS support such an explicit change of states but do not ensure that only one element is focussed at a time.

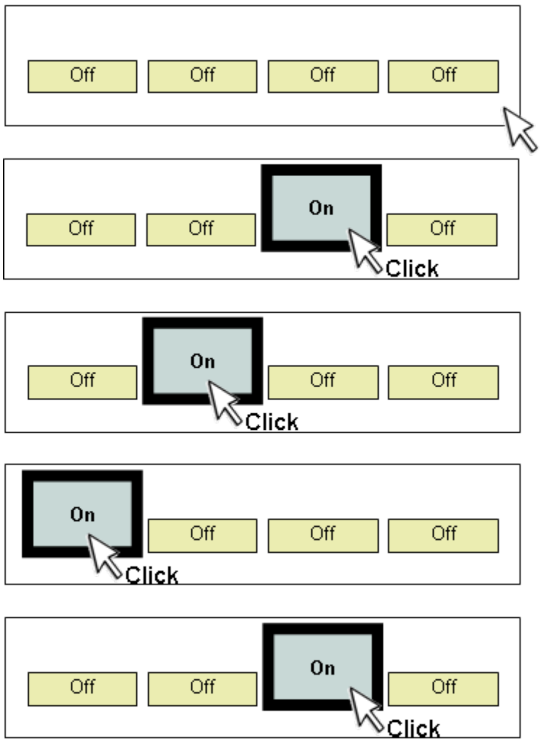
Solution

Allow the user to explicitly highlight or change an element by clicking at it. On activating the element make sure that all other related elements are automatically deactivated.

To highlight the elements of a group, define two different visual states for each element of the group. In other words, define ON and OFF states for each element by varying visual properties:

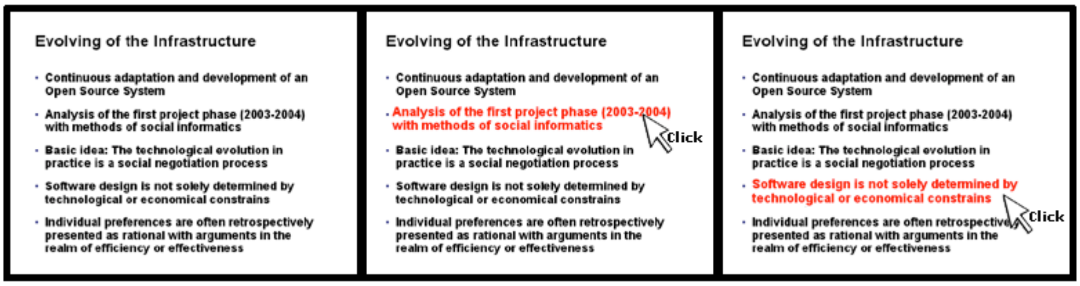


If the user clicks at any of the elements, the clicked element switches to its ON state and all other elements switch to their OFF states at the same time:



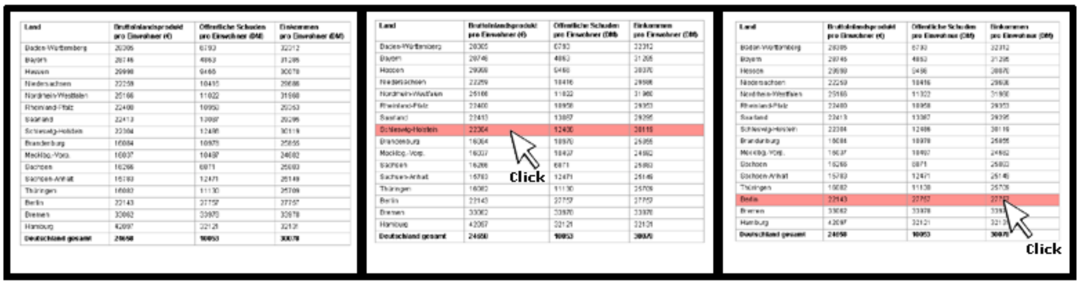
Details

The main purpose of a radio button is to select or activate only one element out of a group at the same time. One can select a single element to focus on it and direct the attention to that element. An element that is highlighted that way stands out and all other elements of the group fade out – either completely or partly. By directing the attention, one reduces the complexity of the graphic because the observer has not to care about all parts at the same time. Also, it is indicated directly which element is currently talked about. In particular, this can help in presentations. One can highlight the bullet item or the row of a table one currently talks about:



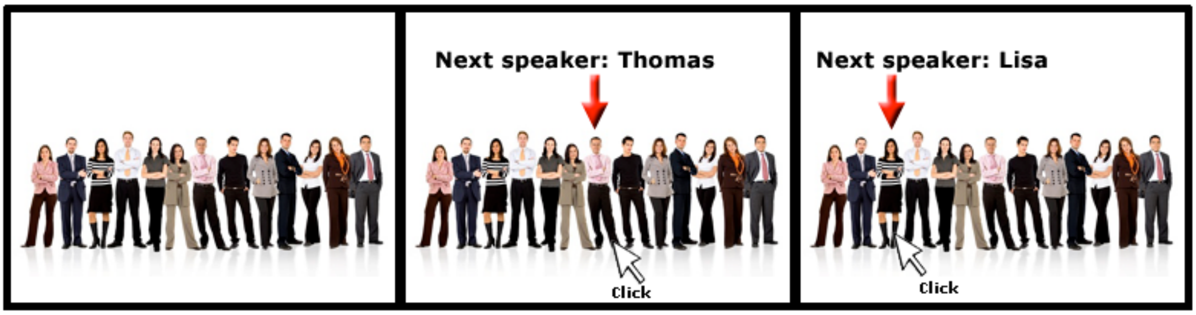
Evolving of the Infrastructure

- Continuous adaptation and development of an Open Source System
- Analysis of the first project phase (2003-2004) with methods of social informatics
- Basic idea: The technological evolution in practice is a social negotiation process
- Software design is not solely determined by technological or economical constrains
- Individual preferences are often retrospectively presented as rational with arguments in the realm of efficiency or effectiveness



Land	Bruttoinlandsprodukt pro Einwohner (€)	Öffentliche Schulden pro Einwohner (DM)	Einkommen pro Einwohner (DM)
Baden-Württemberg	28305	6793	32312
Bayern	28746	4863	31285
Hessen	29998	9465	30078
Niedersachsen	22258	10415	29698
Nordrhein-Westfalen	25166	11022	31960
Rheinland-Pfalz	22400	10950	29353
Saarland	22413	13987	29295
Schleswig-Holstein	22304	12486	30119
Brandenburg	16084	10978	25855
Meckl.-Vorp.	16037	10497	24002
Sachsen	16266	6971	25603
Sachsen-Anhalt	15783	12471	25149
Thüringen	16002	11130	25709
Berlin	22143	27757	27757
Bremen	33062	33970	33978
Hamburg	42097	32121	32121
Deutschland gesamt	**24058**	**10053**	**30078**

Whenever an illustration shows a situation in which only one element can be active concurrently, a radio button is very useful. For example, one can only listen to one radio station at a time (that's where the name "radio button" comes from), only perform one exercise at a time, or allocate scarce resources to only one object at a time. The next example shows how a radio button indicates who the next speaker in a meeting is:



By turning the last activated object automatically OFF, the user input is minimized and the shown information becomes not overloaded.

Once an element is selected to pop out, it remains permanently in ON state until another element of the group is activated. Thus, the mouse pointer is only needed once to activate an element and can be used for different tasks thereafter (in opposition to ROLLOVER BUTTONS which stress the mouse button for the time it activates an element).

If the user clicks at a button that is already in ON state there are two variations to react: the button may either remain in ON state (meaning there is always one of the elements activated) or it switches to OFF state (meaning that all elements are in OFF state).

At the beginning one of the buttons can be set to ON by default. Another option is to have all buttons set to OFF at the beginning. Note that the visual properties that change can be varied individually for each button. For example, one button could change its opacity while the other button changes its colour.

What can I do with this interaction form?

- Highlight or select one object of a group.
- Direct attention to a particular object.
- Show explicitly that for a group of objects only one can be active or activated concurrently.
- Show what to do next or who is in the row next.
- Indicate which object is currently focussed on and handled in a presentation.
- Reduce complexity by hiding or fading all information objects that are currently not needed.
- Focus on objects step by step in random access.

Rationale

A radio button selects one element out of a group and provides and implicit focus [Thi90]. It is taken care of that only one object is highlighted at a time. Thus, accidentally activating multiple objects is prohibited. This is important if the graphic is used to show that only one element should be focussed on or represents a special state. The activation state is automatically transferred between the buttons in the group. Highlighting or focussing an object directs attention and clarifies which object is talked about. Radio buttons allow having all buttons simultaneously visible while assigning one special visual state to one of the buttons. Thus, information can be available at all times but it is assigned with different priorities.

Drawbacks

Each button can only represent two visual states. There is no explicit indicator which element is currently selected because the mouse pointer can move to other positions while the selected element remains in ON state. Thus, the graphic element has to provide its own visual hint that it is activated.

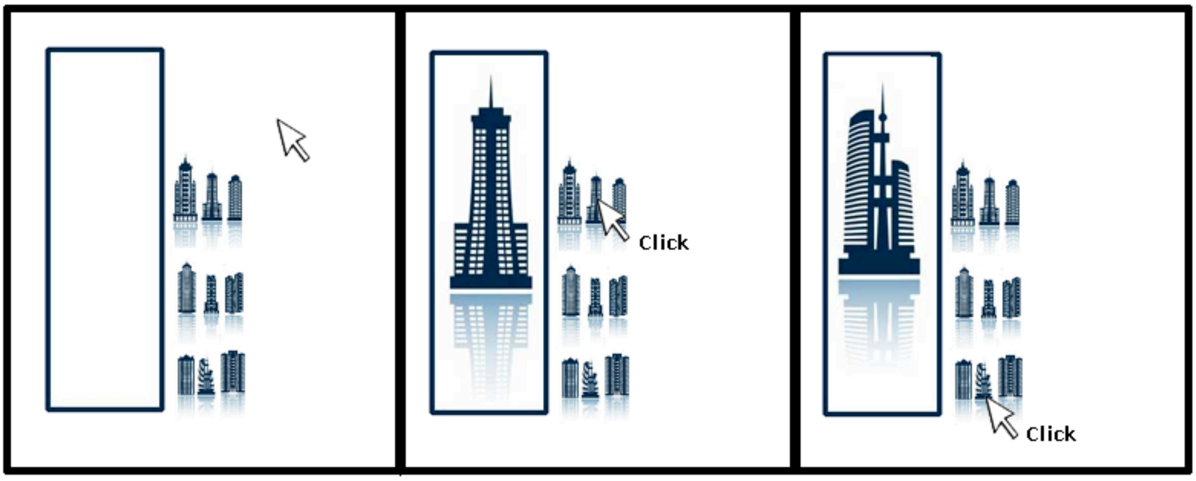
The graphic has to provide affordances to point out which areas are clickable in order to activate one of the radio buttons. These affordances may add an undesirable interference with the graphic itself. Radio buttons are often used to reduce the number of visual elements of a graphic. Hence, if new visual elements are required to activate the buttons, the benefits are nullified. For this reason, radio buttons work best if a base graphic is in use that offers implicitly such affordances, e.g. the bounds of a map or the spatial parts of objects or charts.

Information Display

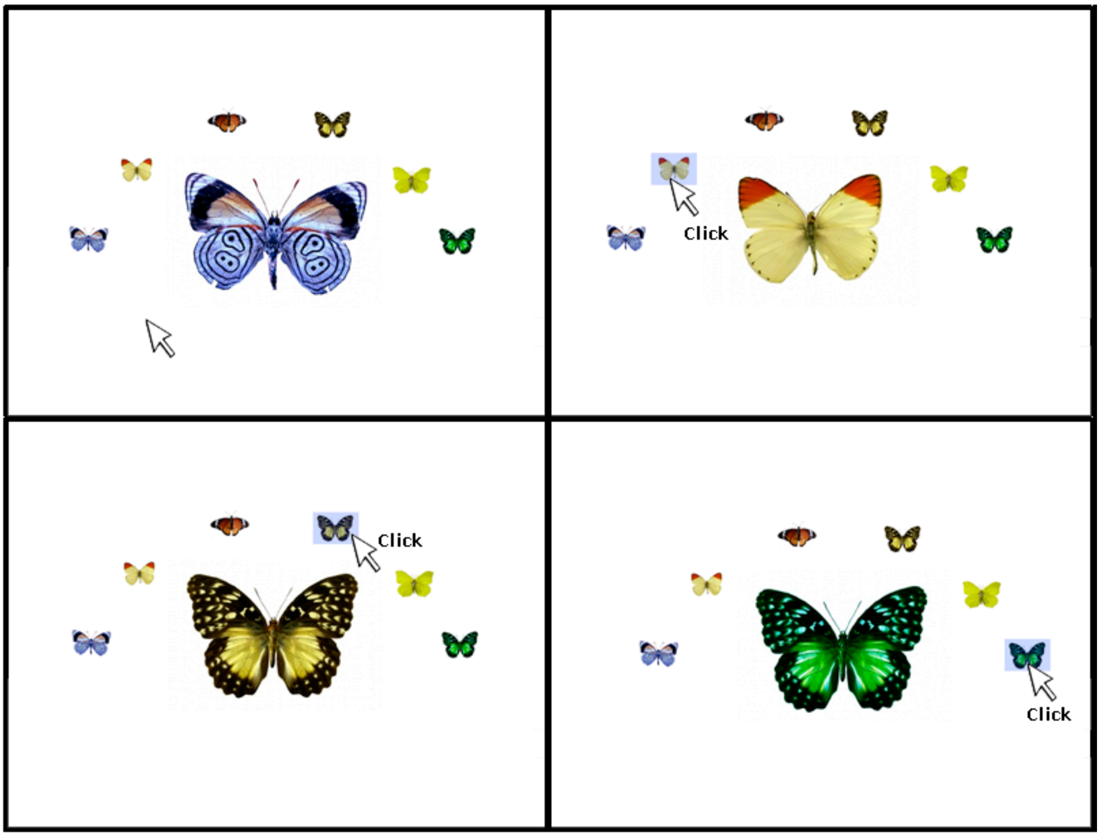
Provide a display to show additional information about other objects on the screen.

Examples

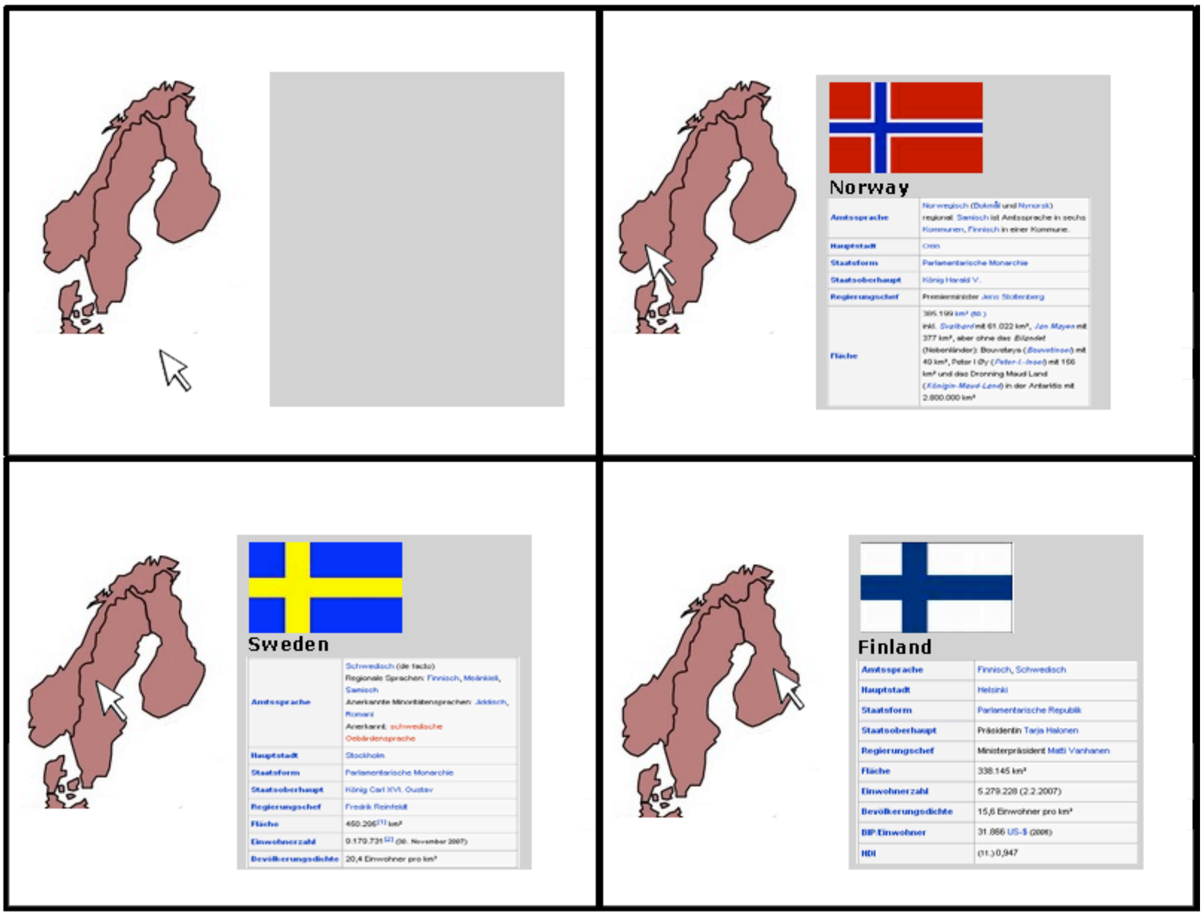
Select a skyscraper: The user can click at one of the skyscraper icons to get an enlarged illustration shown in the box.



Select a butterfly: The user can click at one of the small butterfly icons to replace the large butterfly illustration shown in the centre.



Info box: Clicking at one of the Scandinavian countries sets the content of the grey info box. The name of the country, the flag and statistical information are shown in the info box.



Norway

Amtssprache	Norwegisch (Bokmål und Nynorsk) regional: Samisch ist Amtssprache in sechs Kommunen, Finnisch in einer Kommune.
Hauptstadt	Oslo
Staatsform	Parlamentarische Monarchie
Staatsoberhaupt	König Harald V.
Regierungschef	Premierminister Jens Stoltenberg
Fläche	385.199 km² (60.) inkl. *Svalbard* mit 61.022 km², *Jan Mayen* mit 377 km², aber ohne das *Biland*et (Nebenländer): Bouvetøya (*Bouvetinsel*) mit 49 km², Peter I Øy (*Peter-I.-Insel*) mit 156 km² und das Dronning Maud Land (*Königin-Maud-Land*) in der Antarktis mit 2.800.000 km²

Sweden

Amtssprache	Schwedisch (de facto) Regionale Sprachen: Finnisch, Meänkieli, Samisch Anerkannte Minoritätensprachen: Jiddisch, Romani Anerkannt: schwedische Gebärdensprache
Hauptstadt	Stockholm
Staatsform	Parlamentarische Monarchie
Staatsoberhaupt	König Carl XVI. Gustav
Regierungschef	Fredrik Reinfeldt
Fläche	450.295[1] km²
Einwohnerzahl	9.170.731[2] (30. November 2007)
Bevölkerungsdichte	20,4 Einwohner pro km²

Finland

Amtssprache	Finnisch, Schwedisch
Hauptstadt	Helsinki
Staatsform	Parlamentarische Republik
Staatsoberhaupt	Präsidentin Tarja Halonen
Regierungschef	Ministerpräsident Matti Vanhanen
Fläche	338.145 km²
Einwohnerzahl	5.279.228 (2.2.2007)
Bevölkerungsdichte	15,6 Einwohner pro km²
BIP/Einwohner	31.886 US-$ (2006)
HDI	(11.) 0,947

Context

For illustrative purposes you are using an information graphic in your classroom or in multimedia materials. For specific elements of the graphic you want to provide further information or look into the details. The base graphic should always be visible for reference and any additional information must not hide or replace the base graphic.

Problem

Overlaying the base graphic with additional information sometimes causes interfering with the content, in particular if a large text or image element is added. But placing additional information around the base graphic uses extra space on the screen. The available space is limited due to low screen resolutions. Reducing the base graphic in size decreases its quality and makes it harder to find orientation in the presented screen.

Forces

Adding information spatially close to an inspected object avoids split attention effects but overlay information interferes with the background and often hides important information. This is particularly true for larger pop-up frames.

If extra information is located close to an object, the user perceives it as a description of the objects. However, objects can also be used to add or set information that is only indirectly related to the object.

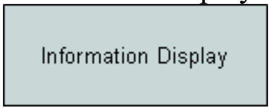
Integrating extra information directly into a base graphic implicitly relates it to contextual semantics but the new information may be independent or related to other contextual information as well.

Adding or changing information in a base graphic forces the user to struggle with the information while s/he may prefer to decide on her/his own when to access it.

Common buttons can change between two visual states but sometimes multiple state representations are required. A mechanism is needed to select one out of multiple states.

Solution

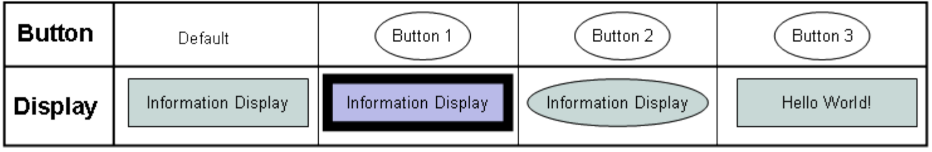
Use an element as a separate information display that can change its visual states to show information about different elements in a base graphic. Set a default visual state for the information display:



Overlay the base graphic with a set of button elements or hot area elements that can alter the visual state of the information display:

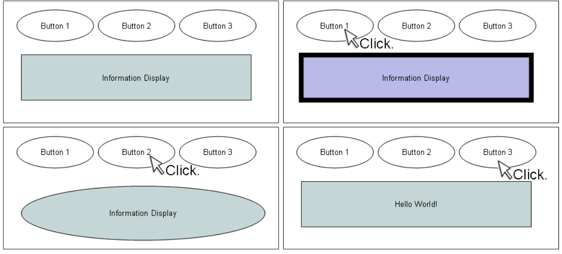
Button 1
Button 2
Button 3

For each button/hot area assign specific visual property values to the information display:

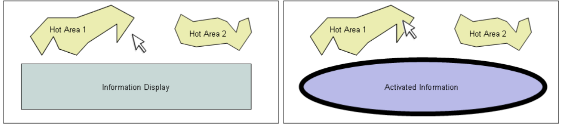


Button	Default	Button 1	Button 2	Button 3
Display	Information Display	Information Display	Information Display	Hello World!

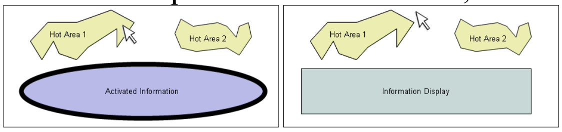
If the user clicks at a button, use the assigned visual state for the information display:



If the mouse pointer enters a hot area, use the assigned visual state for the information display:



If the mouse pointer exits a hot area, use the default visual state for the information display:



Details

An information display can change its content by clicking at a button element or by entering a hot area element in a base graphic. The information display is separated from the base graphic which activates the content of the information display. Thus, the content of the display does not overlay the original graphic and hide or interfere information. Showing extra information in a separate area is less disturbing. However, the larger spatial distance between the focussed area in the base graphic and the information given in the display decreases the overall coherence. Locating the eyes on either the objects in the base graphic or the objects in the information display costs cognitive resources. Using hot areas and mouse rollover to set the information display supports reorientation as the mouse points directly to the area of interest in the base graphic.

This orientation may get lost when using a button object, as the user can move the mouse independently after clicking the button. On the other hand, information displays are less transient if buttons are used.

The base graphic can be complex and the information display can show details or further information about elements of the base graphic. Another option is to use the base graphic as a menu. In this case, the base graphic's elements are menu buttons that can select the content shown in the information display.

Rather than having only two states (like TOGGLE BUTTONS), an information display has multiple visual states. The number of states is set by the number of buttons or hot areas that can set a specific state for the information display. The first shown state can be either an additional default state, or it can be one of the regular button (or hot area) states preset.

The information display is perceived as a passive element on the screen. Therefore, it cannot be involved as a button or hot area itself. If you want to provide a method to reset the information display to its initial default state you should consider an additional button rather than using a click on the display to reset it.

While the separation of the base graphic and the information display increases the spatial distance and makes the complete graphic less coherent, it becomes more clearly what is the base information and what information is additional or more detailed and zoomed in. Not only does the display avoid visual overlapping of information, it also offers a large frame for information if needed. Thus, explaining elements of the base graphic can be done more elaborately than in small pop windows or text bubbles.

What can I do with this interaction form?

- Show a status bar.
- Provide text information for objects on the screen.
- Show details (e.g. a zoom view) for one of the objects on the screen.
- Use the button/hot area objects as menu items to select content.
- Explain components of a larger structure or object.
- Provide information about areas of a map.

Rationale

The main purpose of the information display is to provide details on demand [Shn87]. The base graphic is a means to select which information should be displayed. In that sense it is a visual navigation menu which the user can use to navigate to information nodes. The content of the information nodes is shown in the information display. Menu bars and content frames are a special case of an information display. An information display allows zooming into the details while having the overview picture shown at the same time [War04]. Relations between the big picture and its details are better perceived. Information displays can also be used to show small multiplies [Tuf90] and having one or two of the thumbnails enlarged (e.g. for comparison).

Drawbacks

Information can only be given for one element at a time. Separating labels and images is a cause for split attention effects. The eye's focus has to shift between the information given in the base graphic and the information display. In rollover information displays, the mouse pointer can help for orientation. However, using the mouse pointer for activation disables the mouse for any other activation. Clickable information displays release the mouse for other tasks but it is harder to refocus on the activated area in the base graphic. An interesting option to help this problem is to combine an information display with RADIO BUTTONS that highlight the area in the base graphic which set the display.

An information display never alters the triggering element itself but sets the state for another display. The display is usually at a distant location and has to be perceived as an active element on the screen. If the display is small (e.g. a status bar at the bottom) the user may miss the added information or the change of content.

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