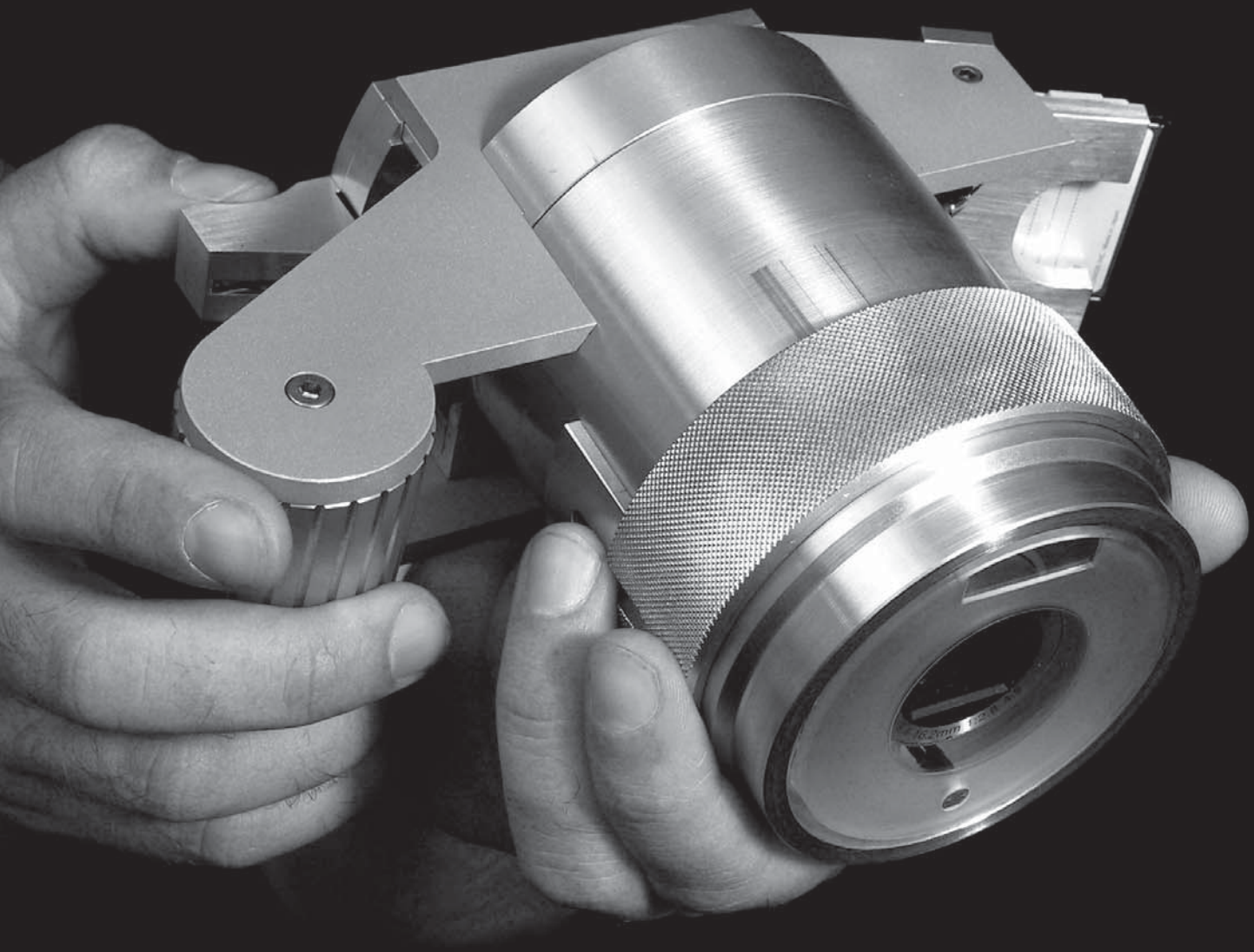

Joep Frens

Designing for Rich Interaction:

Integrating Form, Interaction, and Function

JFS
J.F. Schouten School for
User-System Interaction Research

2 Rich interactive cameras - five scenarios

2.0 Introduction - in this chapter

This chapter focusses on rich interactive products. Previously, I explained what rich interaction is in words. But I believe that what is meant by rich interaction is best demonstrated with product designs. Five digital cameras were designed that differ in interaction style. Five styles were defined to cover a wide solution domain ranging from the known to the unusual. They are presented next, in short scenarios.

2.1 New interaction paradigms - rationale

To spark the creative process of designing rich interactive cameras, five themes were defined. The themes were restrictive so as to force design challenges to the surface, a common practice in creativity techniques (Djajadiningrat et al., 2000b). Still, there was another reason to create the themes. The themes were defined to cover a large area of the potential solution domain for interaction paradigms. I tried to find a balance in the themes between real-world design problems and trends in HCI research. They range from technology driven solutions to human centered solutions and from the pragmatic to the unusual:

1 A digital camera with a minimal amount of controls

2 A digital camera with a control for each of its functions

3 A digital camera that fits the body

4 A digital camera that uses a touch-screen only

5 A digital camera that has no labels on its controls

Method

Knowledge on rich interaction is gained by conducting research through design. In 'doing design' the knowledge that is implicit in design skills is made explicit. Through the process of designing actual product concepts rich interaction is physically defined. Theory on tangible interaction and affordances was applied to the new concept in a designerly manner. The resulting product concepts are physical hypotheses on rich interaction that can be tested in experiments.

In the previous chapter I introduced a framework for exploration. Here I use that framework to design five conceptual cameras. All six fields of exploration need to be explored in order to create rich interactive cameras. But especially the exploration of the relations between form, interaction, and function are essential to integrate them.

The design explorations were done in an experiential manner. A combination of sketching, foam-core modeling and cardboard modeling technique were applied while user-actions were used as a starting point for the designs. Step-by-step combinations of form, interaction, and function were researched, put into form and tested. Thereby exploring all six fields and evaluating their solution domains. The design process is an iterative process in which pre-models are built, tested, and changed until they meet the requirements set by the designer. Through the cycle of building, testing, and changing pre-models, the quality of the combinations was assessed in terms of aesthetics of interaction and information-for-use.

2.2 Five scenarios

2.2.1 Digital camera with a minimal amount of controls (Minimized Amount of Controls Cam)

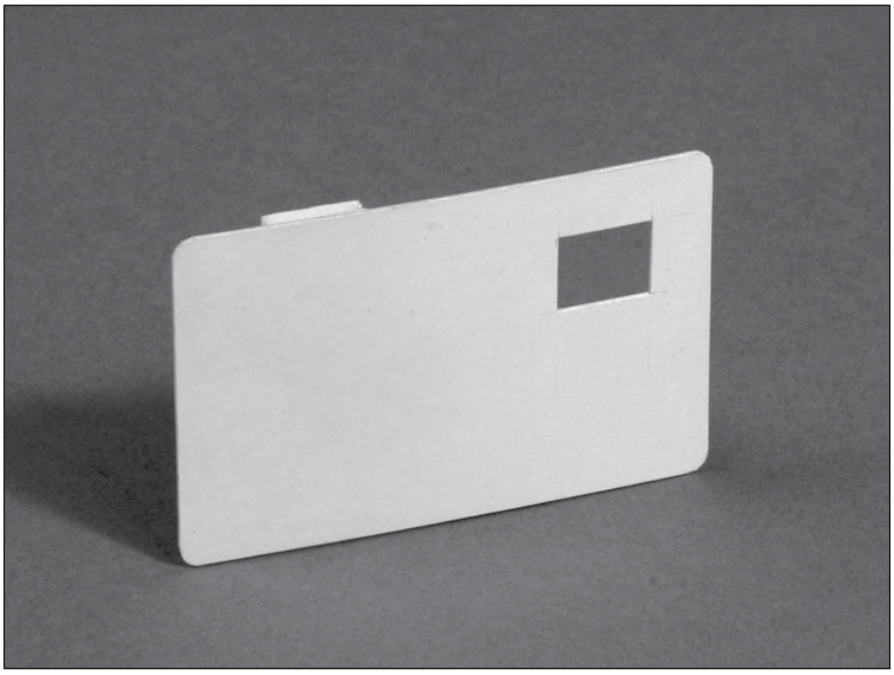

Figure 2.1: Minimized Amount of Controls Cam

Challenge

To design a camera with a minimal amount of controls is to carefully consider the compromise between no controls at all and a control for each function. It has to be decided which functionality is needed in the camera and how many controls are needed to control that functionality. Typically there are more functions than there are controls in such interfaces. This means that a balance has to be found between the usability of the camera and the minimization of the amount of controls. Using one control is arguably the least amount of controls, but is it the minimal usable amount?

Description

This credit-card sized camera features one control, a 'shutter-release' control, see figure 2.2. This control suffices to offer the functionality of a normal click-clack automated camera, but in a special way. The camera depends on its context to function. It has no functional parts other than the control and a tuned-up

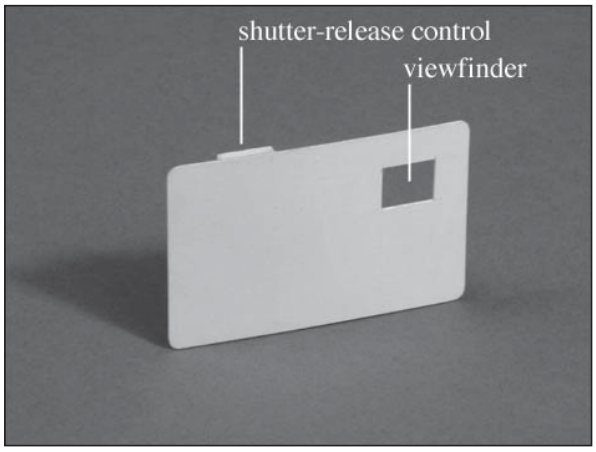

Figure 2.2: Parts

Figure 2.3: Renting a camera

Figure 2.4: Snapping a photo

Figure 2.5: Returning it and retrieving photos

identification tag that is capable of sending its ID, position and orientation. The functionality is taken out of the camera and lives in the environment where the camera is used, see figure 2.3.

The control causes the identification tag to become temporarily visible for a sensing network in the environment that reads out its ID, position and orientation, see figure 2.4. As a result the network 'knows' which camera is 'taking' the picture. Moreover, the network knows from which position in the environment a 'picture' was taken and in which direction the camera was pointing. The network is equipped with a database of earlier made pictures. For example, a collection of high resolution 'normal' pictures or a set of high resolution 'fish eye' pictures. After the camera made its position and orientation available to the network a computer attached to the network is able to compute the picture that would have been taken were the camera equipped with functional hardware.

Figure 2.6: The resulting photo

After a user is finished taking pictures he can go to a distributing point where he can collect the pictures that he made during his stay in the networked environment, see figure 2.5. The camera is brought to a receptacle that scans the ID of the camera. The pictures that were made will become visible on a computer screen and can then be printed, see figure 2.6. Also, if desired the user can make a selection of the pictures that will be printed.

Evaluation of the camera

This camera takes pictures not by using light but by tapping information from the environment. The source of pictures can be anywhere, it can be an image library but it might also be another camera. The active environment generates the pictures that the camera 'makes' and as a consequence it is able to process and enhance the pictures through computation. Besides, a camera such as this allows a novice photographer to take pictures with lighting (or even framing) done by a pro. All in all this is both an advantage and a disadvantage. It can take clean pictures of an object of interest without depicting other persons who are also watching that object, but it won't take a picture of the object of interest together with a friend of yours.

This camera design stretches the concept of digital cameras, for it has no functional camera parts. Its feature-set is reduced to a minimum. However, by bringing the camera to different locations in the active environment it can do everything a normal digital camera can do (e.g., taking pictures, reviewing pictures, printing pictures etc.). The camera belongs to its environment and is as such a physicalization and remote interface of function-

ality offered by that environment. The camera is an example of an interface for an ambient intelligent environment (Aarts and Marzano, 2003).

The camera expresses the fact that it is an interface without functional parts in its form, it is small and has no lens. But it is big enough to fit the human hand comfortably, however, it doesn't have the bulk of ordinary cameras. On the other hand, it does reflect its functionality in its form and interaction. It has a viewfinder and a shutter-release control that resembles ordinary cameras. The camera depends for its information-for-use on both the experience the user has with other cameras and the spatial layout of the environment. Because of the separation of interface and functional parts interesting and surprising things can occur functionality-wise.

This camera has tangible interaction characteristics. For example, it acts similarly to the 'building-objects' that were used in the Urp example (Underkoffler and Ishii, 1999) used in the previous chapter. It can be considered a token in two ways. First, it has no functional parts but is digitally bound to functionality in the environment. Second, images made with the camera are dynamically bound to it for later retrieval.

Three physical properties of the camera are used for it to function; its presence, its position, and its orientation. It also differs from the concept of tangible interaction. By combining two types of 'token-functionality' in one physical object the question is raised if this is an example of tangible interaction or simply an example of a product.

Finally I spend a few words on how this camera might succeed in offering aesthetic interaction. The camera has one control (shutter-release control) and no internal means for providing feedback. Aesthetic interaction must be looked for in the environment. Because the camera acts as a remote interface to functionality offered in the environment, there are lots of opportunities to add surprise to the camera experience. Above I mentioned that the pictures can be enhanced by the environment before they are printed for the user. This opens up a whole new field-for-play where there are ample opportunities to enrich the experience-of-use in an aesthetic manner.

2.2.2 Digital camera with a control for each of its functions (Control per Function Cam)

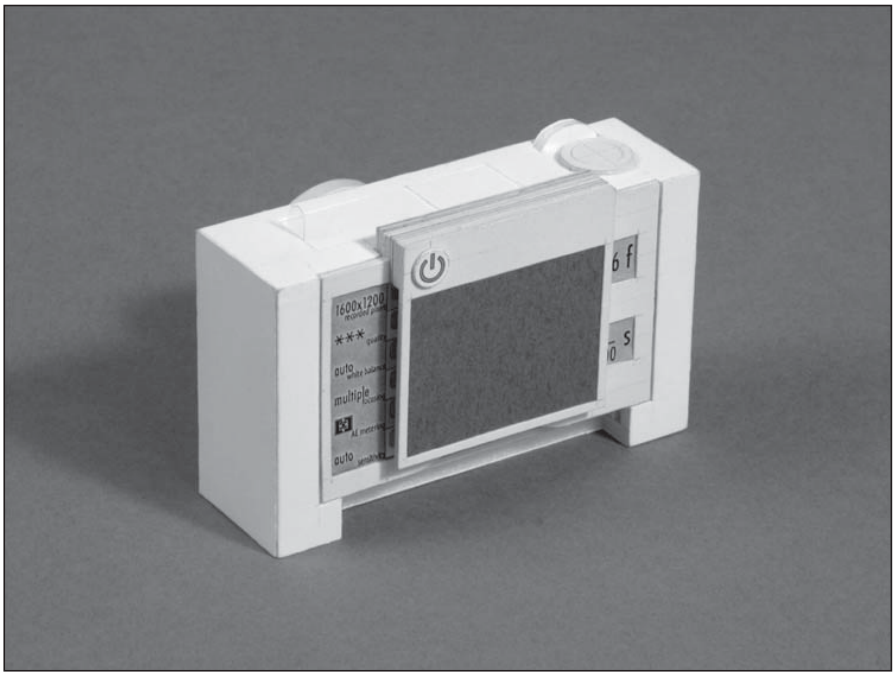

Figure 2.7: Control per Function Cam

Challenge

A camera that features a control for each of its functions has the potential of becoming an explosion of buttons that dwarfs the typical TV-remote in terms of button count and complexity. To design a camera with a control for each of its functions is to find ways to deal with this potential complexity. By definition there is limited space to place controls. A balance has to be found between a bare bones camera and a function and feature rich camera.

Description, using the camera

This camera is intended to offer the functionality of a 'pro-sumer' camera, that is, the camera is fully automated but also offers full manual control over picture settings if desired. On first view the camera looks rather simple, few controls are immediately visible. A power-button, a shutter-release button, and a zoom wheel can be distinguished, see figure 2.8. However, the back of the camera contains several layers of controls, see figure 2.9. On top a viewfinder is visible. Below the viewfinder three black&white screens (one big, two small) are placed that show the camera's settings, see figure 2.10. On the left side of the viewfinder the

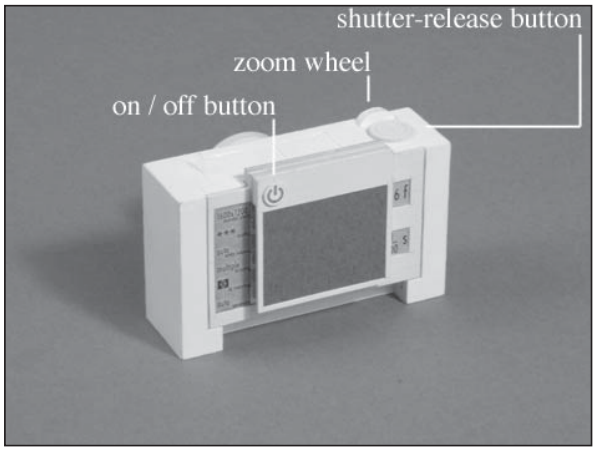

Figure 2.8: Parts

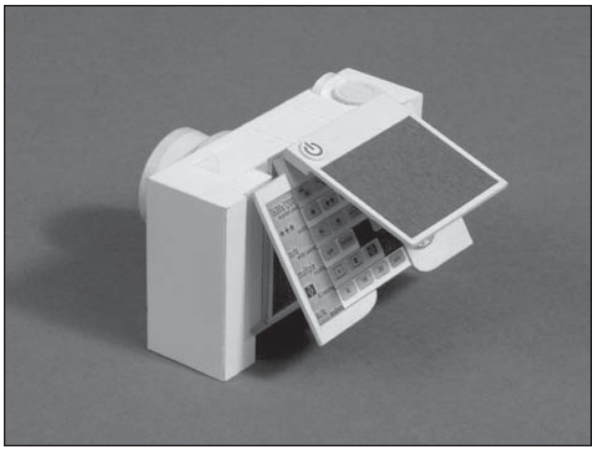

Figure 2.9: Layers of controls

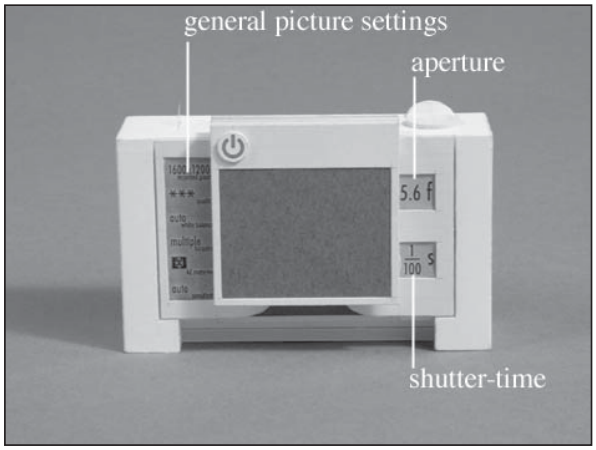

Figure 2.10: Screens at the back of the camera

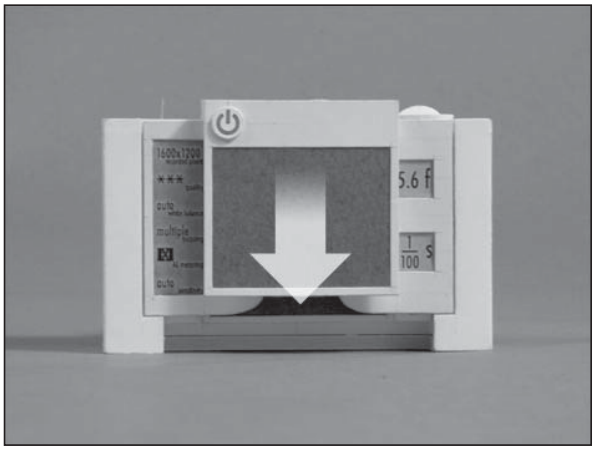

Figure 2.11: Photo flows down

general picture settings (e.g., resolution, compression quality etc), on the right side the dynamic picture settings (i.e., aperture and shutter-time). Below the black&white screens a small part of yet another screen, the play-back screen, is visible.

After the camera is switched on, a picture can be taken by pressing the shutter-release button. The image that was made will flow from the viewfinder screen downwards to the play-back screen. When it reaches the play-back screen this will glow shortly to indicate that it received and saved the picture, see figure 2.11.

When the viewfinder screen is lifted, an array of buttons becomes visible. Those can be used to change the camera settings, see figure 2.12. Also two thumb-wheels are visible. These can be slid to the right to gain manual control over the aperture settings or shutter-time settings or both, see figure 2.13.

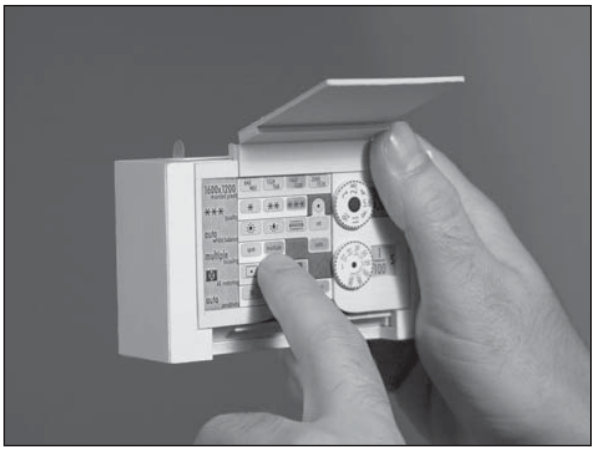

Figure 2.12: Changing camera settings

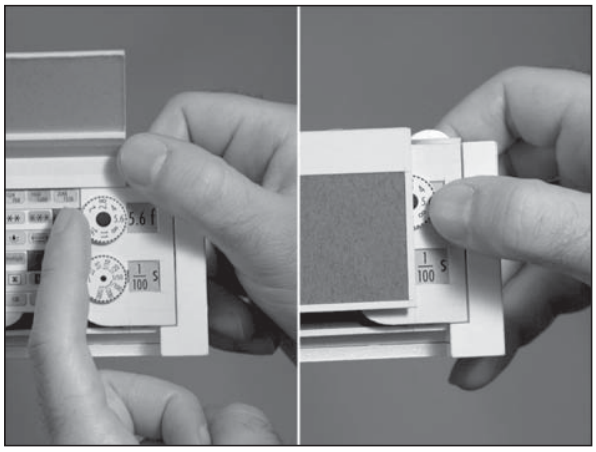

Figure 2.13: Making aperture control visible and accessible

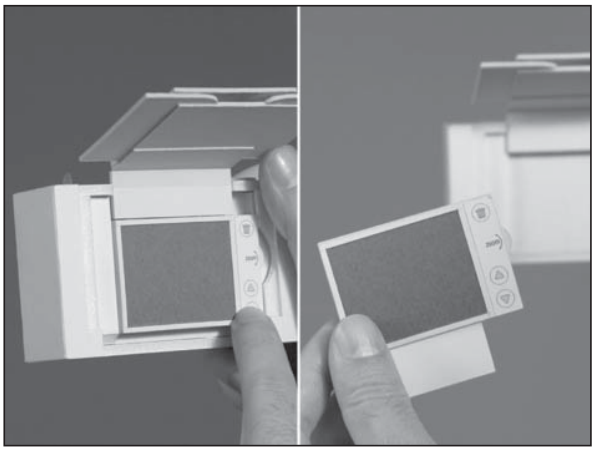

Figure 2.14: Removable play screen

When the layer with camera settings is also lifted, the play-back screen and playback controls become visible. Here the pictures that were saved previously can be viewed by means of a dedicated screen and a set of dedicated controls, see image. Moreover the screen and viewing controls can be taken out of the camera-body for easier viewing, see figure 2.14. The memory card is placed behind the play-back screen.

One can choose to have manual control over the focus area by pressing a button at the side of the lens. This causes a zoom ring to slide out of the body, covering the button that causes it to appear, see figure 2.15. The ring is ready to be used as focus ring. If automatic control of focus is desired, the ring can be pushed back into the camera-body.

Finally, if necessary a flash-light can be deployed. The flash is stored in the camera-body and can be manually flipped out. A thumb-wheel on the flash gives control over flash-settings (e.g., anti red-eye flash, flash-level, etc.), see figure 2.16.

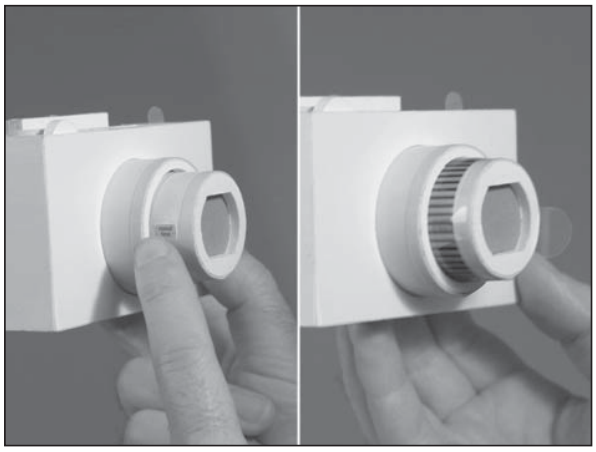

Figure 2.15: Manual focus

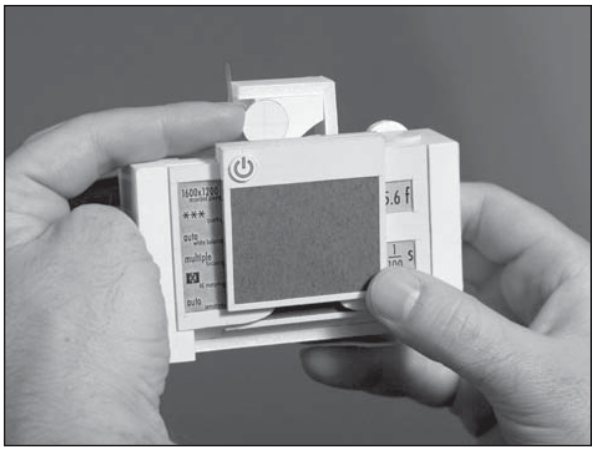

Figure 2.16: Pop-up flash

Evaluation of the camera

This camera concept offers full camera functionality with a straightforward mapping of control to function. By choice it can be either manually or automatically operated. No menu-structures are present, no buttons are functionally overloaded and the user is not confused by modes-of-use that alter the operation of the camera. The functionality of the camera is grouped in physical layers that can be folded open. If all layers are closed the camera is in camera-mode, if the viewfinder screen is flipped open the camera is in setting-mode and if the layer with camera settings is also lifted the camera is in view mode. The camera thus naturally switches modes if the relevant controls for that mode are brought forward.

This camera concept elegantly brings together form, function, and interaction. Mode switching, generally considered a source of user-frustration, is done by manipulating the form of the camera. Making a control accessible switches the camera in the appropriate mode (e.g., if the aperture control wheel is made accessible the camera goes from automated mode-of-use to aperture-priority-mode). The camera links interaction possibilities to the form, but also links the functionality to the interaction-form combinations. Information-for-use is given both through conventionally labeled controls and the relations between form, interaction, and function. Moreover, the camera guides the user. For example, by providing visible feedback of the process of making and saving images (the picture that is made flows down to the play-back screen).

Tangible interaction principles found their way to this camera in a subtle manner. For example, mode switching is made physical by means of layers, the flash unit is physically brought up or pushed down, and the manual focus ring is physically pushed back into the camera enclosure if the camera should auto-focus. The camera employs direct interaction principles in a physical manner. The best example of the influence of tangible interaction is found in the way the manual controls for setting aperture and shutter-time are implemented. To manually control the aperture the aperture thumb-wheel is slid over the small screen that normally displays the automatic aperture setting. Thus making the thumb-wheel not only the control, but also the display of aperture. On the other hand, this camera is in many ways not a tangible interface. It employs conventionally labeled buttons and screen-feedback. Moreover, for those controls the user actions in this camera are rather small and standardized.

Finally, I would like to discuss the possibilities in which this camera might offer aesthetic interaction. This camera tries to prevent user frustration by eliminating user modes and functionally overloaded controls. Thus the stage is set for aesthetic experiences. Those might be found in how the camera gives feedforward and feedback (e.g., the picture that flows down towards the play-back screen, the zoom ring that comes forwards to provide manual focus, and is the zoom-wheel coupled to the lens movement). But they might also be found in how the controls feel (e.g., how does it feel to flip through the layers or how does it feel to snap a picture).

2.2.3 Digital camera that fits the body (Body Fit Cam)

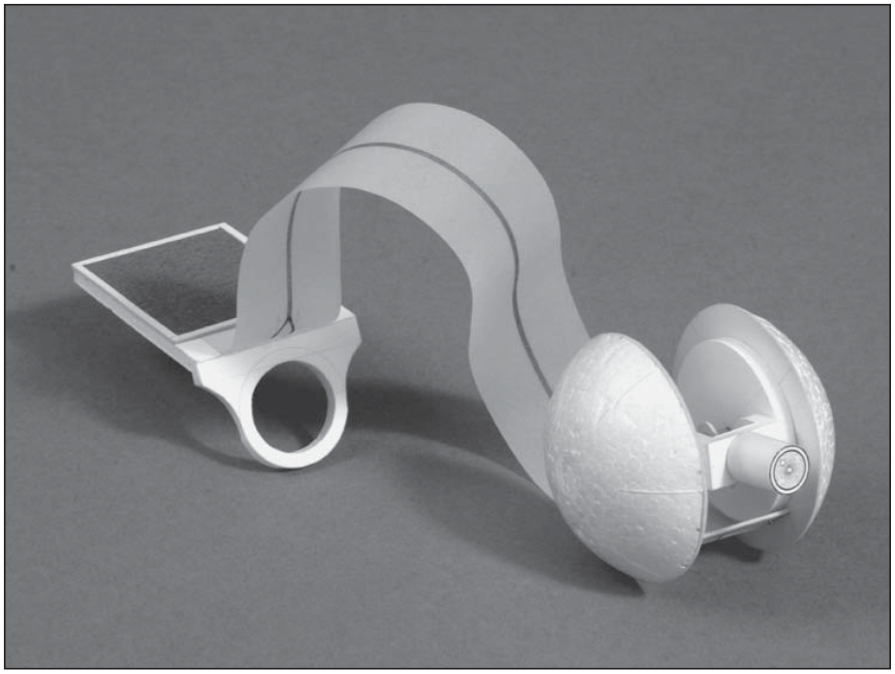

Figure 2.17: Body Fit Cam

Challenge

To design a camera that fits the body is an ambiguous challenge. The first question which has to be answered is what is meant by 'to fit the body'. It can literally mean that the camera fits the form of the body. But it can also mean that the camera fits the bodily skills of a user, interaction wise. When designing such a camera the challenge is to fit both form and interaction to the body and perceptual-motor skills of man.

Description, using the camera

This camera offers limited functionality and is intended to be a gadget for active young people. Its strength is that it offers the opportunity to express your skills with the camera in the picture. How the camera is operated influences the picture quality. The camera fits to the palm of the hand and is meant to be carried around at all times, see figure 2.18. At first view it has no controls at all. However, in reality the camera itself is one big control.

To take a picture the ball that houses the camera is 'thrown' outwards, like a yo-yo, see figure 2.19. The ball rolls out over its spring during which the camera will power up. When it reaches

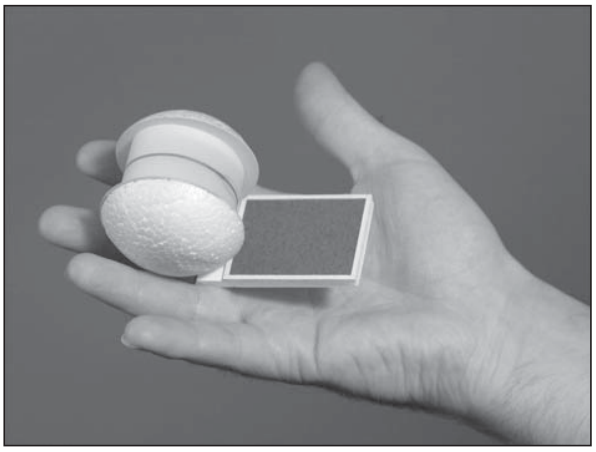

Figure 2.18: Camera in hand, ready to throw

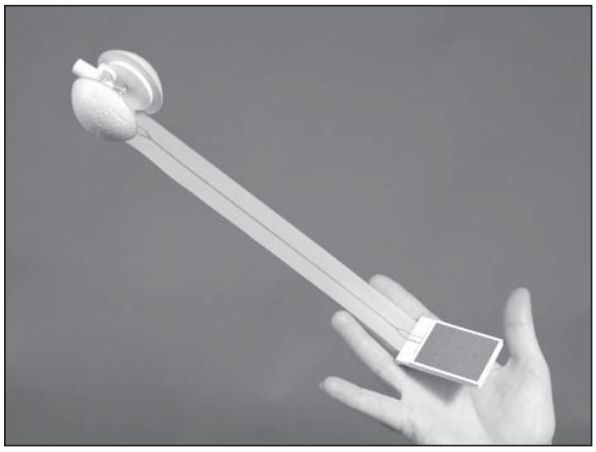

Figure 2.19: Grabbing a photo

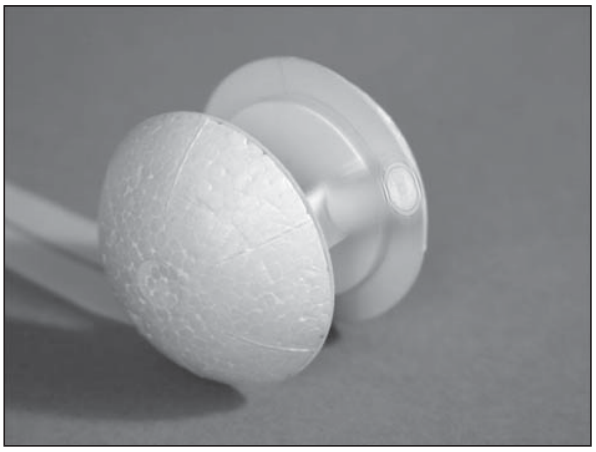

Figure 2.20: The lens snaps out

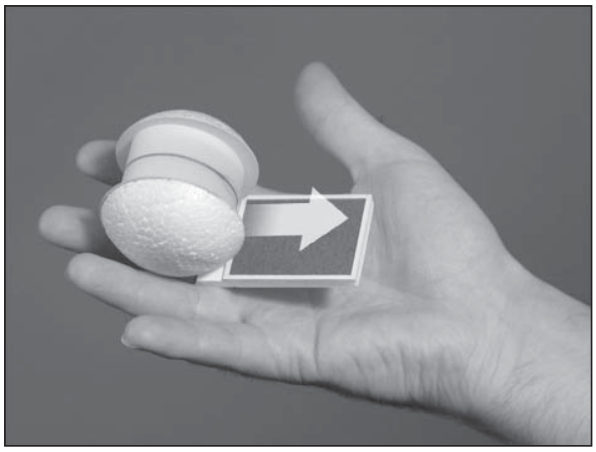

Figure 2.21: Camera rolls back, the photo appears on screen

the end of the spring the rotational momentum causes a small, fixed focus lens to swing out and snap a picture, see figure 2.20. The lens folds back into the ball and the whole thing will roll back over its spring to the palm of the user's hand to bring the grabbed picture to the screen where it is saved, see figure 2.21. The picture will be visible on the screen for a minute, or shorter if the user decides to grab another picture. If the user does nothing, the screen will switch off after that minute.

Evaluation of the camera

This camera concept offers a limited feature set operated by broad expressive actions. Skill is needed to operate the camera: it is not easy to snap a picture with it. However, if the 'art' is mastered of snapping out the camera and having it hang somewhat stationary in the air at the end of its rolling motion, new opportunities of making pictures become available. Motion blur becomes some-

thing that can be played and toyed with, thus giving expressive qualities to the pictures that originate from the users skills with the camera.

Limited feature-wise, rich in interaction, this camera brings together form, function, and interaction in yet another way. The functionality is expressed in the form, but also in the interaction. Images are literally grabbed by throwing the camera towards the object of interest. Moreover, the form begs to be thrown to capture images. Not only are rich actions necessary to capture images, with practice, their expressive qualities can be used to enhance the picture. Information-for-use is given in two ways. First, the form of the camera and how it fits the hand express that it can be thrown. Second, information on 'functioning' is given by the expression of the images on the screen.

This camera resembles Hummels and van der Helm's (2004) interpretation of tangible interaction that was highlighted in chapter 1.1. Broad expressive actions are needed to operate the camera while the expression of these actions is reflected in the images that are made with it. Besides, the camera can be seen as a system of tokens and constraints. Both the camera part and the display part are tokens that can contain pictures, the spring is a constraint. If the camera 'token' is thrown out it takes a picture at the end of its constraint before it rolls back towards the display 'token' and deposits the picture in it. The process of grabbing and displaying is made physical.

The camera offers an interesting opportunity in which it might offer aesthetic interaction. There is a direct, expressive coupling between the action and the result. This might elicit an aesthetic experience. On the other hand, if a user does not master the skill of 'grabbing' images, the camera will probably soon start to be frustrating.

2.2.4 Digital camera with a touch-screen only (Touch-screen Cam)

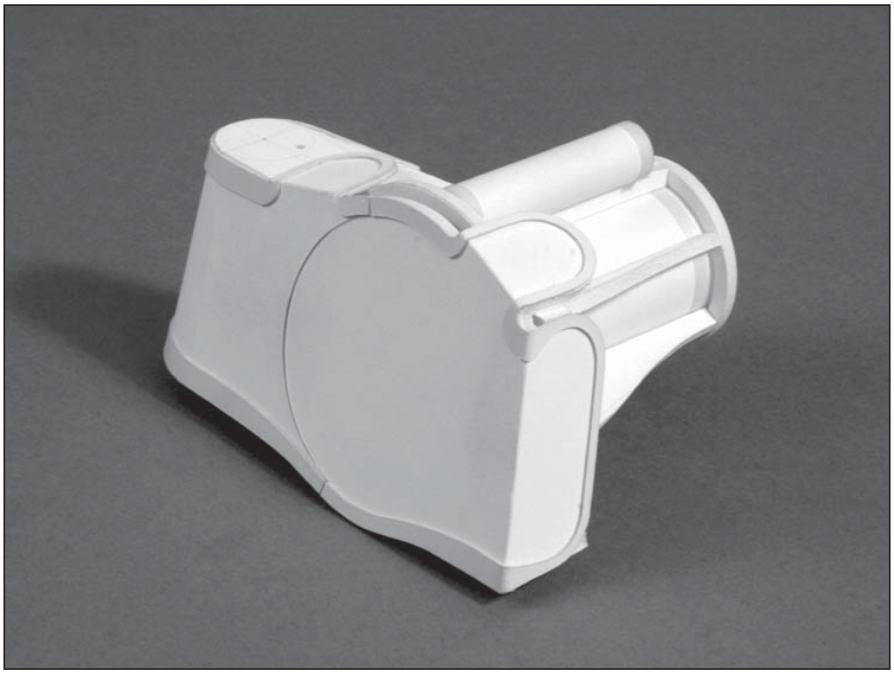

Figure 2.22: Touch-screen Cam

Challenge

In designing a camera with just a touch-screen a designer has to invent new ways of interacting with digital devices. Everything you know of the devices around you suddenly does not count anymore, for to exploit the new possibilities that a touch-screen has to offer known button solutions are obsolete. Careful consideration of what a touch-screen is, and what it is not, is needed to step beyond the scaled computer interfaces that live on PDAs.

Description, using the camera

This camera deploys no other control than a touch-screen which is wrapped around the functional parts of the camera. The right hand part of the touch-screen can be taken off of the camera, see figure 2.23. It has its own (limited) power supply and stays wirelessly connected to the camera. The camera offers different sets of functionality. It is fitted with several pre-defined sets but users can also define the functionality of the camera themselves. Besides functionality normally found in digital cameras it offers some special features.

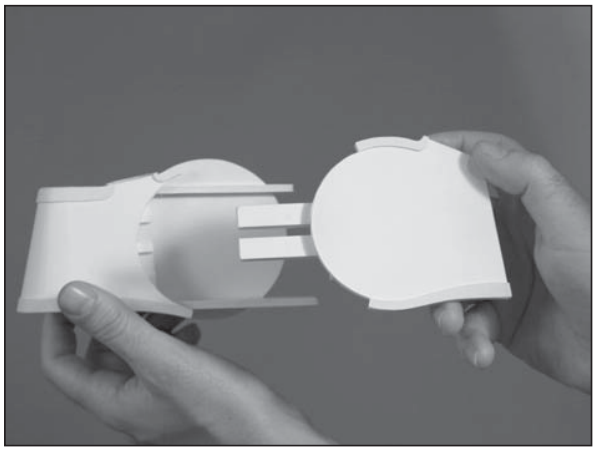

Figure 2.23: Camera can be taken apart

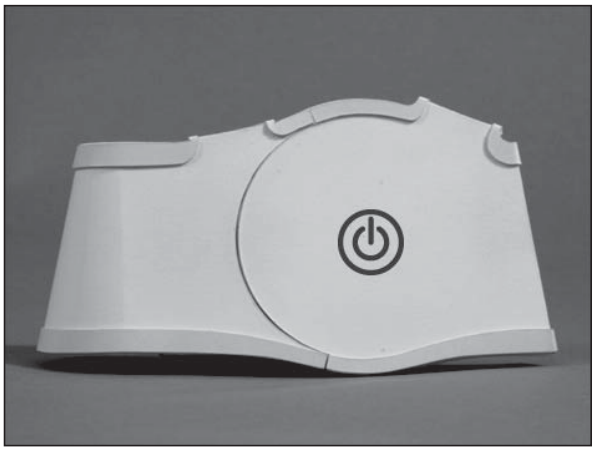

Figure 2.24: Power button

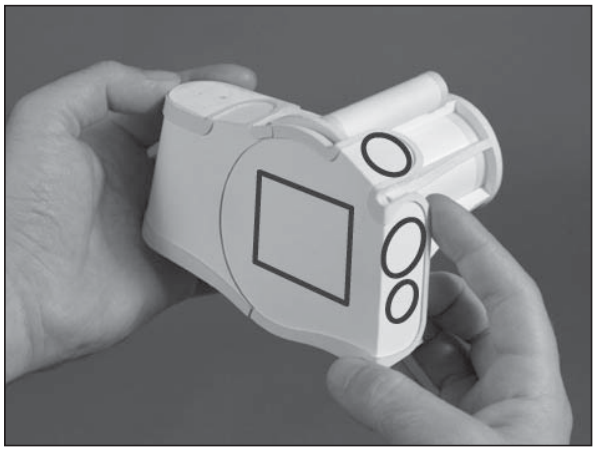

Figure 2.25: Normal camera setup

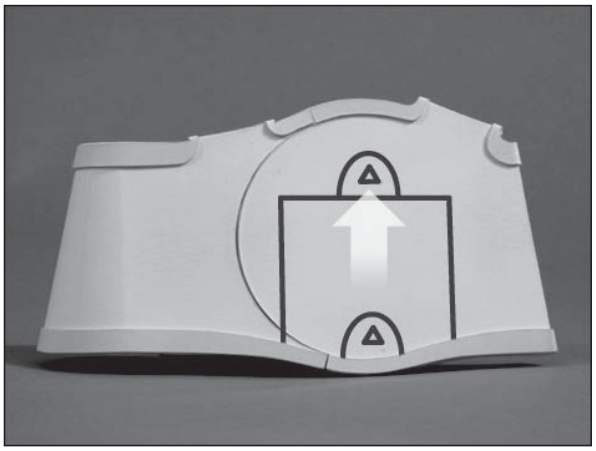

Figure 2.26: Widget library control

The camera switches to sleep mode when not in use. To switch it on a power control is pressed that is visible in sleep mode, see figure 2.24. The screen will light up and depending on how it is set the camera will show a particular set of controls. If the camera is set to be an ordinary digital camera it will show a shutter-release control, a viewfinder, and zoom controls, see figure 2.25. The camera is used in the same way ordinary cameras are used. The picture is framed by moving the camera and by zooming. If the picture looks good, the shutter-control is pushed.

The controls that are visible on the camera can be modified. Every control has 'handles'. These can be used to move and scale the controls. Also, a library of controls is supplied. This library can be summoned by pushing the library control, see figure 2.26. If the library is visible, controls can be added to, or taken from the interface of the camera. Also available from the library are the pre-defined sets of functionality. By modifying the controls the functionality of the camera can be changed.

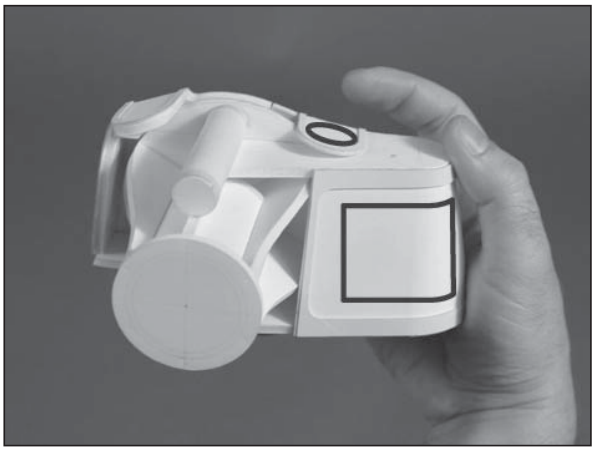

Figure 2.27: Self-portrait camera setup

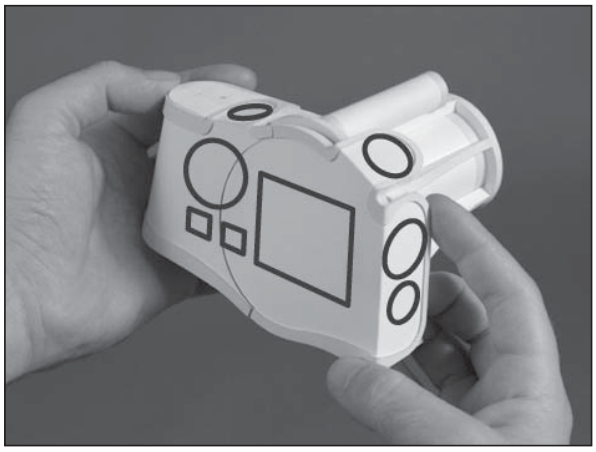

Figure 2.28: Pro-sumer camera setup

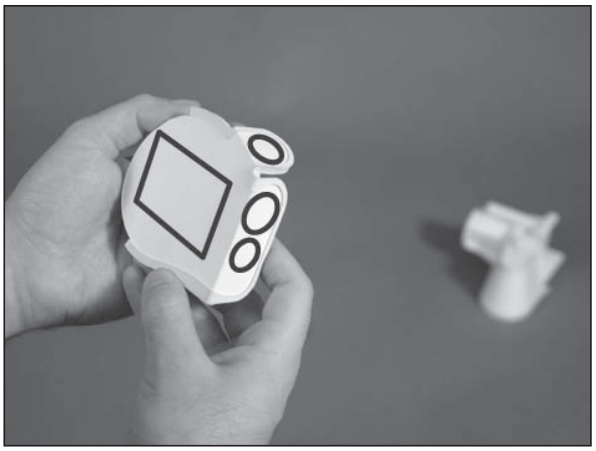

Figure 2.29: Remote controlled camera setup

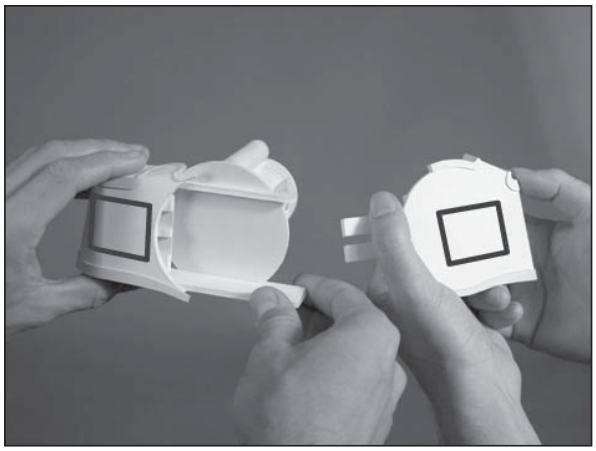

Figure 2.30: Democratic camera setup

As described earlier, the camera can be an ordinary digital camera, see figure 2.25. But by shuffling the controls, the camera can be a 'self-portrait' camera, see figure 2.27. Or by adding controls the camera can be a full fledged 'pro-sumer' camera, see figure 2.28. By putting all the controls on the detachable part users can control the camera remotely, for example to take group pictures, see figure 2.29. Or by cloning the controls and putting them both on the camera and on the detachable part two people can have control over the same camera at the same time, see figure 2.30. Thus users of the camera can explore and define the functionality of the camera themselves.

Evaluation of the camera

This camera concept offers full user configurability. It is a concept open for exploration of functionality by the user himself. But the camera can also behave like any other camera by means of presets. The strength of the concept is not so much that func-

tions can be added or taken away: the whole functionality of the camera can be changed. Not only can it be changed from an automated click-clack camera to a pro-sumer camera, it can be changed from an ordinary camera, to a self-portrait camera, to a remote controlled camera.

Form, function and interaction come together in this camera in an open manner. Obviously functionality and interaction are strongly related. For to add interface widgets is to add functions. But, more importantly, form plays a big role in this. Because of the form the overall functionality of the camera can be changed too. By having a touch-screen that wraps around the camera parts, the controls of the camera can be placed in any which way the user finds necessary or comfortable.

This camera provides information-for-use both in graphical user interface style, with icons and in form. The form of touch-screen invites users to place icons at any convenient place thus allowing for the exploration of function.

During the design of this camera it became clear that touch-screens and tangible interaction are somewhat incompatible, especially when it is made explicit that the camera was to employ a touch-screen only. Direct interaction principles are applied for the interaction with this camera. Still the interface of the camera essentially is a graphical user interface, not a tangible user interface.

Aesthetic interaction will not be found in tactile sensations because the touch-screen provides no other force-feedback than the reaction force of the user's finger pushing against it. The options for aesthetic interaction are to be found in the movement of graphical objects over the screen and how this movement is coupled to the movement of the finger controlling those objects. It is very possible that the widgets on the screen elicit playful behavior. For example, one can sling around the widgets over the screen and the widgets can move around the corners of the screen, and widgets can be loaded onto the detachable part for remote use.

2.2.5 Digital camera without labels on its controls (Labelless Cam)

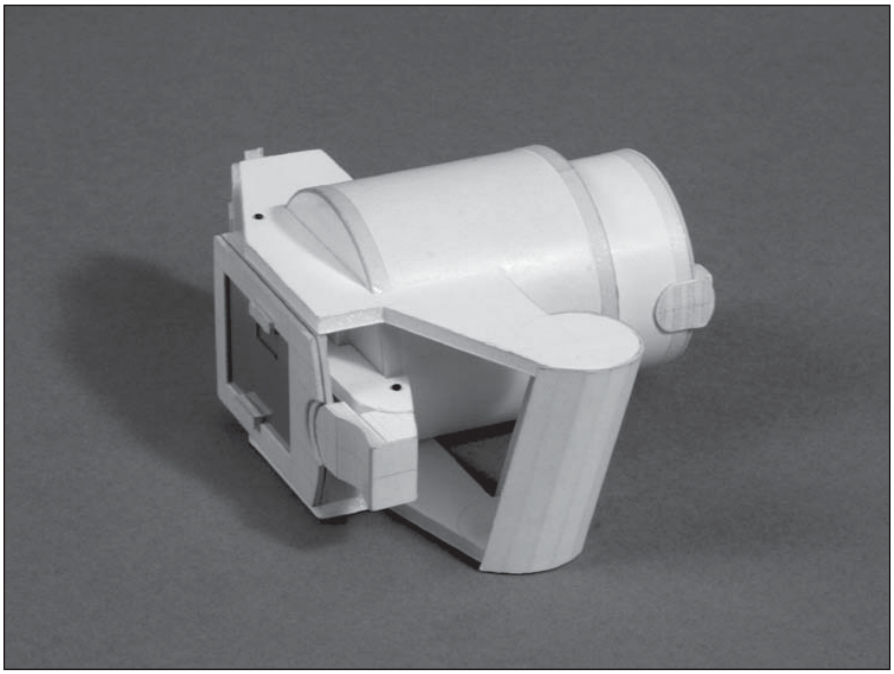

Figure 2.31: Labelless Cam

Challenge

To design a camera with no labels on its controls is to design information-for-use in form and interaction. Ways have to be devised to tell a story of use without using text or pictures. Not only have the controls of the camera to be given forms that express their functionality, the overall form of the camera has to support the expressivity of the controls and it has to express that it is a camera itself.

Description, using the camera

This camera offers basic camera functionality that is expressed in its form and in the interaction with the camera. The operation of the camera is action based. The camera controls and parts are prominently visible and determine its looks. The controls of the camera provide feedforward and feedback, they express what can be done with them, they express what will happen if they are used, and they show what happened after they are used.

When the lens-cap is taken off the lens, the camera switches on and displays the image on the screen at the backside of the camera, see figure 2.32. The pixel-size of the photos can be set

Figure 2.32: Switching the camera on

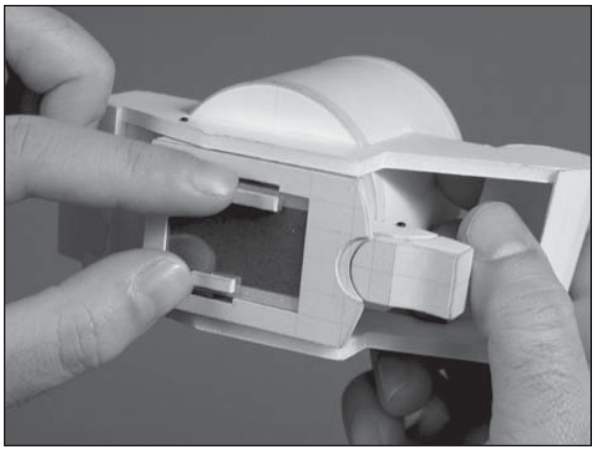

Figure 2.33: Resolution scalers

Figure 2.34: Zooming

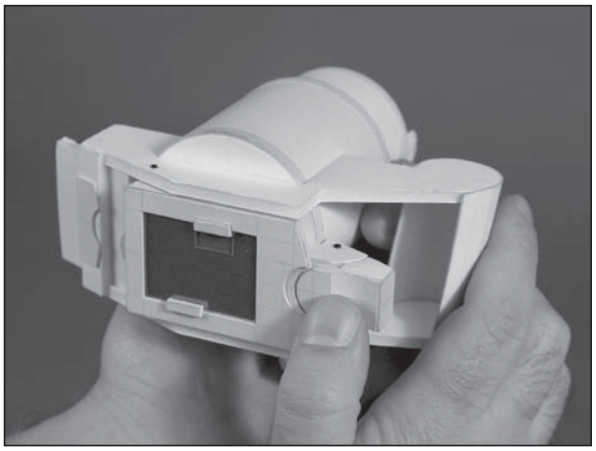

Figure 2.35: Take a photo

(e.g. 2560x1920 or 1600x1200) by changing the size of the screen with physical 'scalers', see figure 2.33. At the sides of the lens two small handles are placed. When the handles are pulled the lens comes out of the body and one can zoom in on the object of interest, see figure 2.34.

The trigger restrains the screen to the lens. The screen is aligned with the lens which relays the images that it captures in a steady stream to the screen. When the composition seems good, the trigger can be used to capture the image, see figure 2.35. If it is pushed it will release the screen which will flip away from the lens by means of a spring (screen open position) thus breaking the connection between lens and screen, see figure 2.36. As a result the image on the screen 'freezes' and one is given the opportunity to review the photo. It now can either be saved or deleted.

When the photo is satisfactory it is saved by moving the screen towards the memory card, see figure 2.37. The photo will 'flow' from the screen into the card, the screen blanks. The screen is

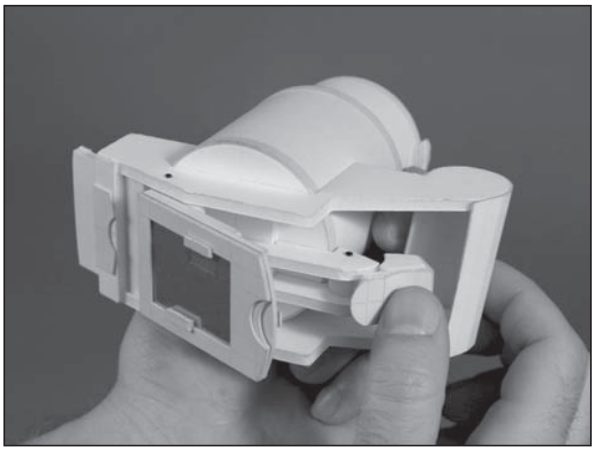

Figure 2.36: Review photo

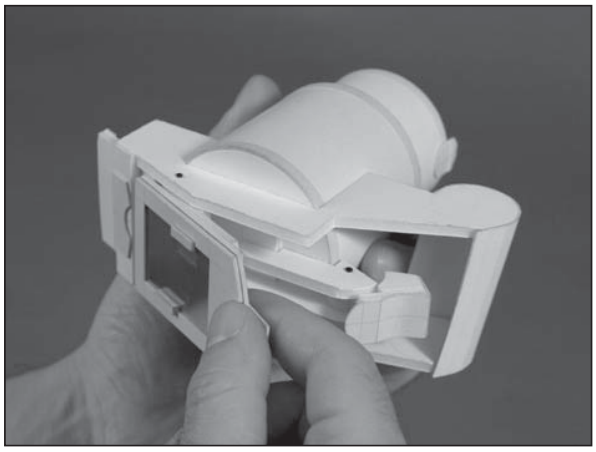

Figure 2.37: Saving photo

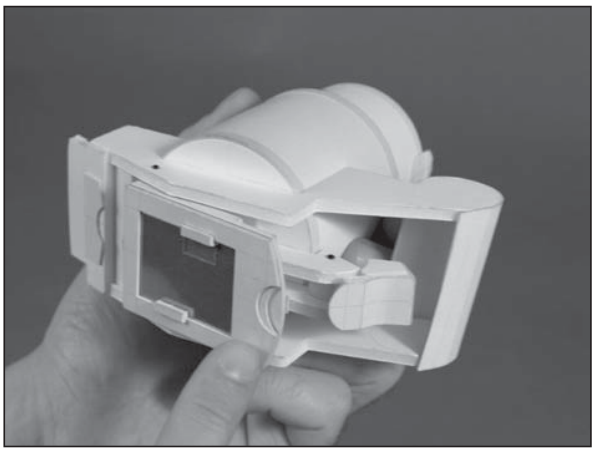

Figure 2.38: Deleting a picture

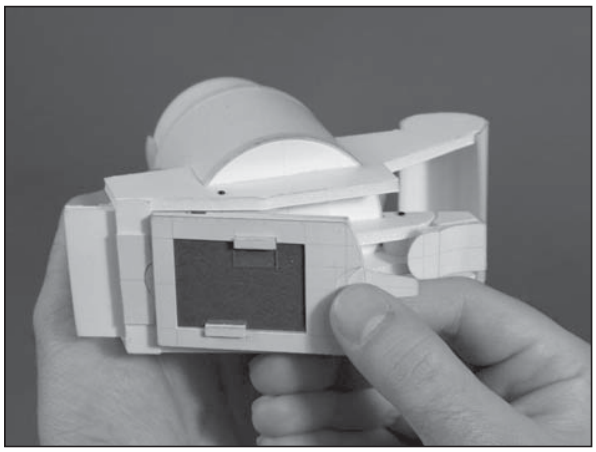

Figure 2.39: Go to viewmode

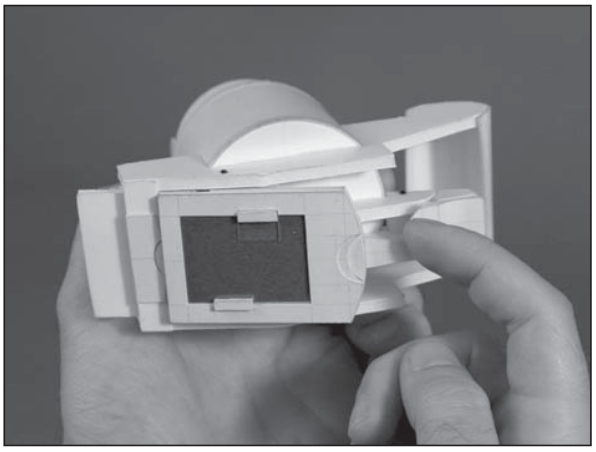

Figure 2.40: Browsing photos

spring loaded and will return to the screen open position when released, it can then be clicked back against the lens and a new picture can be made.

If however the photo is not satisfactory the screen is clicked back against the lens immediately, the image is not saved and disappears, see figure 2.38. A new picture can be taken.

If the screen is held against the memory card, it locks into place and it will start to display the images that were stored in the memory card, see figure 2.39. Those images can be browsed using a small lever that is exposed when the screen is moved towards the memory card, see figure 2.40.

Evaluation of the camera - what are the rich qualities

This camera employs rich actions to operate the camera. The parts of the camera are also the controls and by means of moving, rotating, and connecting them the functionality is opened. The camera offers only the controls that are relevant to the mode-of-use. Moreover, to bring the camera in different modes-of-use is to move the parts of the camera to different positions thus making it easy for the user to recognize which mode-of-use the camera is in.

The camera brings together form, interaction, and functionality in a very direct manner. Through manipulation of form the functionality is reached. Moreover, the process of taking pictures is made visible in the form (and the dynamics of changing the form) of the camera.

Information-for-use is provided in form. The controls express both how they can be operated and what will happen if they are operated. A good example of this is how a picture is taken. The trigger visibly and physically restrains the screen to the lens, if the trigger is pushed the screen is released, thus making a photo. The trigger expresses pushing. The screen is locked to the lens, if it releases the informational link between lens and screen is broken, it will thus make a picture.

This camera also employs tangible interaction principles. The best example can be found in how the screen functions and is operated. The screen acts both as a relay of the moving image as it is captured by the lens and as a container of still images. If the screen is released from the lens, thus becoming available for manipulation, it starts acting as a container. By manipulating the physical screen enclosure the digital image is manipulated. It can be saved by moving the screen towards the memory card, the screen is then emptied. Or the image can be discarded by restoring the relay function of the screen.

As for aesthetic interaction, this camera offers many possibilities. Relatively large actions are needed to control the cameras, the controls offer a big 'action-travel'. Therefore there is room for the camera controls to be tuned for 'feel'. For example, to save an image is to push the screen towards the memory card, the 'feel' of this movement can be tuned by applying different springs. But there is more, user-actions and product reactions are coupled in a meaningful manner. For example, movement leads to movement: if the trigger is pushed to take a picture, the screen flips open as a result and if the screen is pushed towards the memory card to save a picture, the picture flows towards and in the memory card. Such coupling is in line with Wensveen's 'interaction-frogger' framework that advocates amongst others a unity of direction (Wensveen, 2005).

2.3 Mode-relevant action-possibilities and mode-of-use reflected in physical state

While designing the five concept-cameras I found that two typical characteristics kept resurfacing as a result of the integration of form, interaction, and function. First, mode-relevant action-possibilities. Second mode-of-use reflected in physical state.

2.3.1 Mode-relevant action-possibilities (MR APs)

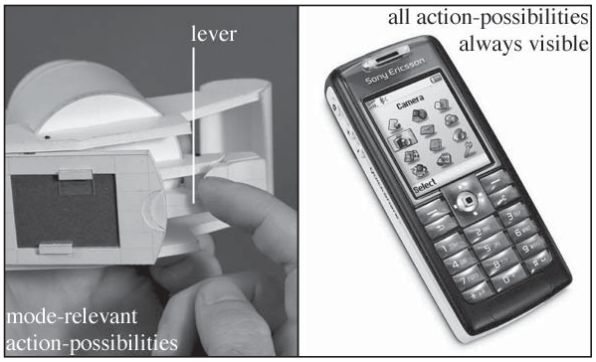

Figure 2.41: Mode-relevant action-possibilities

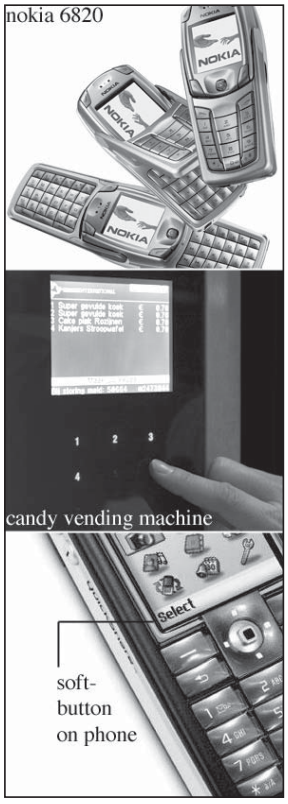

Figure 2.42: Product examples

Mode-relevant action-possibilities are action-possibilities that are only offered when they are relevant for the mode-of-use. For example the lever to browse saved pictures is only accessible when the 'Labelless Cam' is in view-mode. This contrasts with products with ordinary interfaces that often show all action possibilities all of the time, even if these action-possibilities have no function, see figure 2.41.

Still, there are products on the market that seem to offer MR APs, for example the two keyboards, one for numbers, the other one for letters, on the Nokia 6820 cell-phone, the back-lit controls of a candy vending machine, or the soft-buttons on most mobile telephones, see figure 2.42. Although it can be argued that particularly the soft-buttons on a cell-phone are not really mode-relevant action-possibilities but mode-relevant labels there are other reasons why such MR APs differ from those of the RUI camera.

The first reason is dedication, implicit in the MR APs concept is the fact that MR APs are dedicated to a function.

The second reason is integration, MR APs are integrated in the form and functionality of the product. This means that there is no difference in making a mode switch or in making MR APs

available, this is the same 'action', it is integrated. Moreover, there are meaningful relations between form, interaction and function.

The third reason is expressiveness, MR APs are expressing their functionality in form and interaction.

2.3.2 Mode of use reflected in physical state (MURPS)

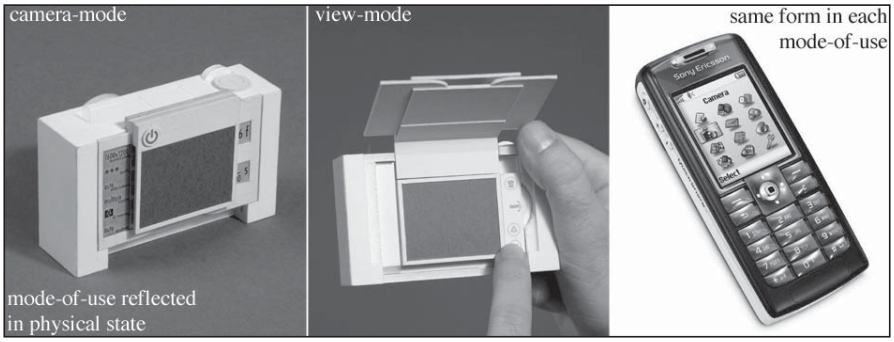

Figure 2.43: Mode-of-use reflected in physical state

The camera reflects its mode-of-use in its physical state. That is, in each mode-of-use the form of the camera is different. For example the 'Control per Function Cam' looks different when in camera mode than when in view-mode. This differs from ordinary interfaces which commonly don't change shape, but are always of the same form, see figure 2.43.

Again there are products on the market that seem to reflect their mode-of-use in their physical state. For example, the N90 camera phone from Nokia that changes form to resemble a video-camera or a cell-phone, or, again, the flip-open QWERTY keyboard of the Nokia 6820 phone, see figure 2.44. The features that those two phones offer indeed come close to MURPS as they were demonstrated in the RUI camera. There appear to be some differences though.

Figure 2.44: Product examples

The first difference again is integration, when the mode switches the physical state should adapt and, vice versa, when the physical state adapts, the mode should switch. In the phones this seems not to be the case. First the physical state is adapted by the user after which the phone has to be brought in the appropriate mode.

The second difference is autonomy (symmetry), the camera's physical state adapts 'itself'. That is, the action that leads to the change of mode-of-use also leads to a change in form. The reflection of the mode-of-use in the form is not caused by a

separate, extra action, it is completely ingrained in the interaction with a rich interactive product. In the product examples that are described above the change of form is always initiated by the user. If the Nokia 6820 phone in the example above is put in texting-mode, the user can choose to flip out the QWERTY keyboard. That keyboard does not flip out as a natural result of changing the mode-of-use. And the mode-of-use does not change as a natural result of the keyboard being folded out.

2.3.3 What about the literature?

These two characteristics that surfaced reverberate the areas of inspiration nicely. Gaver discusses the notion that affordances can be revealed over time as a result of previous actions, he names this *'sequential affordances'* (Gaver, 1991, p. 82). These sequential affordances are similar to the MR APs. In a context of tangible interfaces Gorbet discusses the coupling of physical actions to functions. Gorbet states that *'the modes of operation of most purely physical objects are easily selected and intrinsically indicated through their physical state'* (Gorbet, 1998, p. 39). He argues for the *'linking of physical state and digital mode'* (Gorbet, 1998, p. 38) in interactive products to reduce mode errors. This linking of physical state and digital mode is similar to the MURPS that were discussed above. Interestingly, Gorbet makes little distinction between (what I would call) MR APs and MURPS. He sees MR APs as a natural result of MURPS. Although this is true in case of the 'purely physical objects' (non-interactive products) that Gorbet discusses. I do want to make the distinction between MR APs and MURPS. Because MR APs and MURPS play different roles in integrating the form, interaction, and function of rich interactive products.

When it comes to the expression of function in form, MURPS is necessary and sufficient while MR APs are necessary but not sufficient. MURPS explicitly changes the form of a product, therefore, it also changes the meaning of the product. MR APs do not inherently change the form of a product, they are often the result of a form change.

In the expression of 'interaction' in form this is the other way round, MR APs are necessary and sufficient while MURPS are necessary but not sufficient. MR APs offer only the action-possibilities that are relevant for use. MURPS often facilitates MR APs, but MURPS alone does express what one can do with a product.

2.4 Summary

In this chapter five cameras were presented that demonstrate the concept of rich interaction. Instead of giving a detailed description of rich interaction I decided that a demonstration of the concept was more appropriate. The strength of rich interaction is not easily captured in words. Rich interaction is a concept that comes to life in interactive products through the tight integration of form, function and interaction. Not as an afterthought but in the hands-on process of designing a product.

Five cameras were presented. As demonstrated rich interaction can take many forms. It was shown that rich interaction is not an interaction-style in itself. It is a design approach where form, interaction and function are a unity, it spans interaction styles. The cameras are physical hypotheses, quite extreme hypotheses.

Two typical characteristics were found that seem to be indicators for rich interaction; mode-relevant action-possibilities and mode-of-use reflected in physical state. Two of the camera concepts have both of these characteristics; the 'Control per Function Cam' and the 'Labelless Cam'. When the unity of form, interaction, and function of these two cameras is compared I think the 'Labelless Cam' possesses the most expressive relations between the factors. Therefore I choose to investigate the concept of rich interaction further through the 'Labelless Cam'. To investigate the concept further an explorative experiment is set up to test a camera with a rich interface against an ordinary camera. In the next chapter I present this experiment.