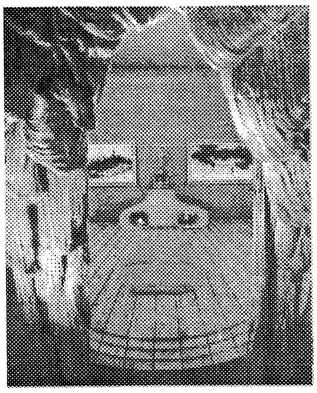
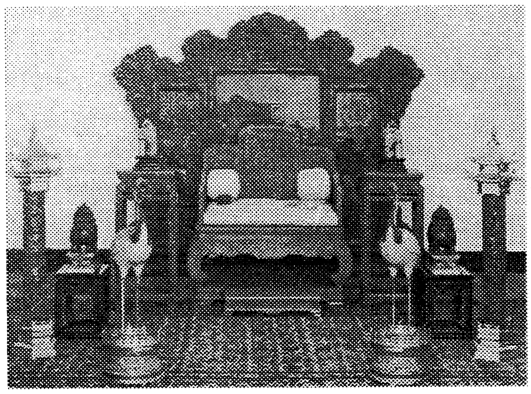
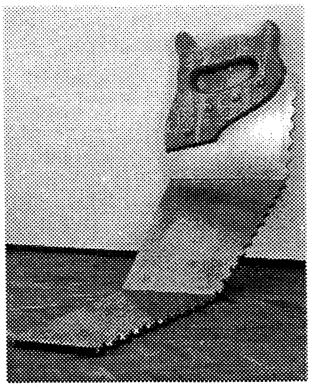
PLU-616

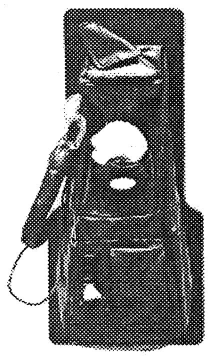
Reader
Vormtheorie I - IDE220

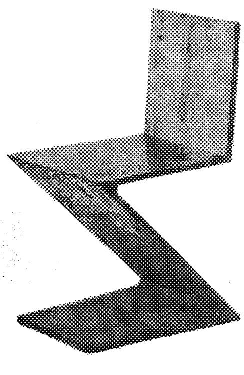
Maart 1999

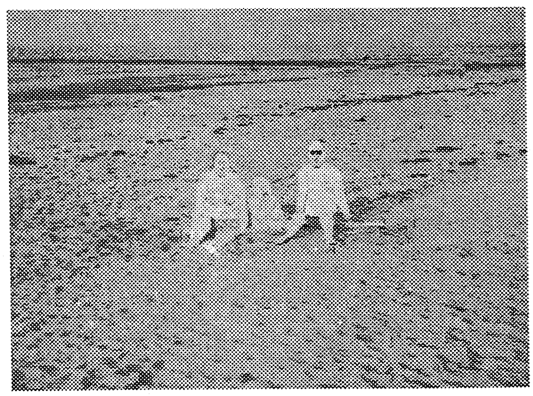












TU Delft

Faculteit Ontwerp, Constructie en Productie
Subfaculteit van het Industrieel Ontwerpen
Afdeling Industrial Design
Sectie Vormtheorie

INHOUD

1. Knipsels over electronische producten & frustraties

2. Schema Vormtheorie.

3. Hummels, C.C.M. (1999). *De geur van liefde en haat*. In: Geur en ontwerpen: Monografieën over vormgeving.

4. Djajadiningrat, J.P. & Overbeeke, C.J. (1998). *Let the body in: On the relationship between form giving and usability*. To be submitted.

5. Picard, R.W. (1997). Introduction. In: *Affective Computing*. The MIT Press, Cambridge, MA.

6. Gaver, W., Dunne, A., & Pacenti, E. (1999). *Cultural probes*. Interactions, Vol.6(1), 21-29.

7. Strong, R. & Gaver, W. *Feather, scent, and shaker: Supporting simple intimacy*.

Wintertijd

DAGENLANG hield ik hem tersluiks scherp in de gaten: wanneer werd het nou eens wintertijd op mijn videorecorder? Toen ik hem ooit kocht, bleek hij de vanzelfsprekende knopjes om de tijd in te stellen, te ontberen. De juiste tijd wás er gewoon, die kwam geheel zelfstandig ergens uit het zwarte gat achter de kabelaansluiting. Fantastisch, dacht ik. Mijn aanwinst leek alweer een beetje meer op de ideale videorecorder. Tot afgelopen zondag dus. Want al was de wissel van zomer- naar wintertijd tot dan toe steeds vanzelf gegaan, deze keer bleef het ding halsstarrig de zomertijd aangeven. Na drie dagen werd ik ernstig ongerust. Misschien moest ik toch iets doen? Maar aanzetten, uitzetten, afspelen, opnemen, van zender wisselen, niets hielp.

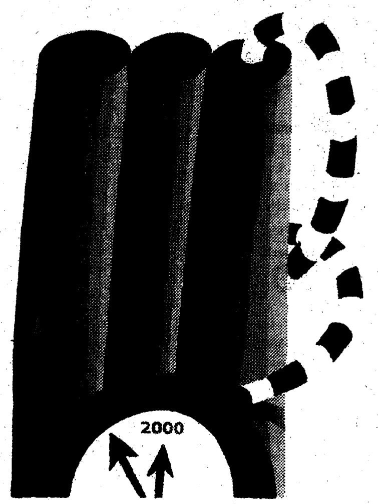
Dus ging het halve huis op de schop om het langvergeten boekwerk dat voor handleiding doorgaat op te sporen. En daarin stonden, op pagina 64, de verlossende woorden: "De tijd wordt in de teletekst-modus met programmaplaats 1 automatisch geactualiseerd". Teletekst! Dat kon kloppen. Sinds begin dit jaar heb ik een nieuwe televisie, eindelijk eentje die zelf teletekst heeft, en dus gebruik ik de teletekstfunctie van de video niet meer. Meteen proberen. Toevallig staat het apparaat ingesteld op RTL, en dat heeft Teletekst. Naks. Is RTL-teletekst misschien niet goed genoeg? Laten we Nederland 1 eens proberen, en verdomd, 18.32 wordt zomaar, bij toverslag 17.32. Gered!

Maar toch blijf ik nu met een hele rij vragen zitten. Wat is programmaplaats één, en waarom doet de ene teletekst het wel en de andere niet? Waarom ging de aanpassing naar zomertijd dit voorjaar wel vanzelf, terwijl ik toen ook die nieuwe tv al had? Waarom snap ik eigenlijk nog steeds niet hoe het zit, en vergeet ik de procedure dus geheid opnieuw? En waarom moet ik uren bezig zijn met zoiets lulligs als een klok gelijk zetten?

En dan is er mijn nieuwe wondertuner, die ook al de tijd aangeeft. Ook die bleef denken dat het zomer was. Dus op naar het volgende installatieboek, waar een los vel uitsteekt. 'IMPORTANT' staat bovenaan dat vel. En daaronder, in zes kromtalen, maar niet in het Nederlands, de mededeling: "de klok binnen dit product wordt automatisch gelijkgezet door de CT-functie van RDS". Geheimtaal, maar RDS, daar staat ie op! Alleen is er nergens een knopje met de aanduiding CT te bekennen. Dus toch maar de handleiding zelf ingedoken, en inderdaad. Daar vinden we op bladzijde 12 de verhelderende mededeling dat CT staat voor 'Clock Time'. Die modus moet je eerst activeren, door vijf keer op een knop te drukken, en dan zet de klok zichzelf geheel automatisch gelijk. Daarna moet je nog een paar keer op diezelfde knop drukken om weer in de normale werktoestand uit te komen.

Wat een feest. Zijn we daarvoor nou duizenden jaren geleden uit de holen gekropen? Opdat we met behulp van veel studie volautomatisch handmatig een klokje gelijk kunnen zetten?

Nee, natuurlijk. De apparaten om ons



ILLUSTRATIE MILO

geven ons wel degelijk de kans om dingen te doen die zonder technologie domweg onmogelijk zijn. We kunnen dankzij de video inderdaad de wereld levensecht registreren op een stukje tape, we kunnen de meest krankzinnige regressieberekeningen maken dankzij het spreadsheet, en we kunnen onmiddellijk met vrijwel elke medemens ter wereld praten alsof hij naast ons zit dankzij het gedigitaliseerde telefoonnet. Het vervelende is alleen, dat technologie maar de helft van het verhaal is. Aan de andere kant van die technologie zit altijd weer een mens, die eisen stelt waar ook de slimste ingenieur doorgaans maar weinig kaas van gegeten heeft.

De videorecorder is het voorbeeld bij uitstek van dat spanningsveld mens en machine. Hoe knap een apparaat ook bedacht en gebouwd is, pas als de afstemming met de gebruiker, de 'interface', ook in orde is, kun je spreken van een bruikbaar product. Bij de videorecorder is die afstemming legendarisch slecht, zodat het ding veel gebruikers bang en onzeker maakt, en veel functies ongebruikt blijven. Bij moderne telefooninstallaties is het niet anders. Veel knopjes, die door heel wat gebruikers gemeden worden als de pest. Software, met zijn bijna onbegrensde mogelijkheden, vertoont uiteraard hetzelfde euvel. Elke gebruiker weet dat uit ervaring, maar inmiddels realiseren fabrikanten zich dat ook, en proberen ze er serieus iets aan te doen.

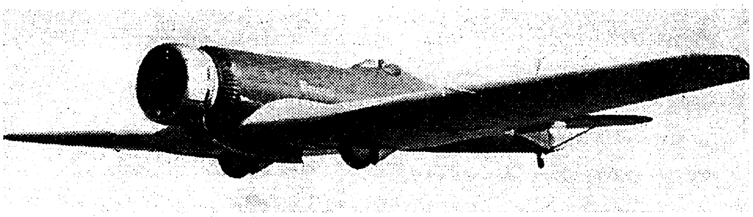
Maar hoe meet je of een programma bruikbaar is? Aan softwareontwikkelaars heb je niets, die kijken te veel met andere ogen dan de consument. Die consument heeft zo hun eigen vuistregels ontworpen. Bijvoorbeeld: "zitten er meer dan tien knoppen op (onderkant en zijkanten meetellen!), dan is het hooguit iets voor je secretaresse". En: "telt de handleiding meer dan tien pagina's: nooit doen". Er zit wat in die regels, maar voor een fabrikant blijven ze te vaag, net als de soms nogal verwarde klachten die een helpdesk krijgt. Grote softwaremakers spelen daarom tegenwoordig leentjebuur bij de psychologie. Ze richten observatiekamers in, waar ze meten hoe vaak en wanneer proefgebruikers bij een opgegeven taak de wenkbrauwen fronsen, aarzelen, vloeken, opnieuw beginnen of de handen in wanhoop ten hemel heffen. Het verschil met een psychologisch experiment is, dat deze keer niet de eigenschappen van de proefpersoon ter discussie staan, maar die van de taak, het programma waar de proefpersoon mee werkt.

De 'Start'-knop van Windows95 is een van de eerste resultaten van zulk onderzoek. Proeven met de eerste ontwerpen voor Windows95 lieten zien dat mensen met alleen het bureaublad geen kant op konden. Het is een bescheiden resultaatje, niet meer dan een schaamlap voor de inherente ondoorzichtigheid van Windows95/98. Ga maar na: wie kan bijvoorbeeld uit het hoofd vertellen hoe je van een automatisch opstartend programma afkomt? Het is ook, jammer genoeg, weer een typische ingenieursoplossing: als de consument te stom blijkt voor het product, geef hem dan nog een extra klungelknop. In feite riep de verbijstering van de proefpersonen natuurlijk om een compleet herontwerp van de kennelijk verkeerde interface. Maar dat eist, vrees ik, meer inzicht in en acceptatie met eigen feilbaarheid dan ingenieurs en programmeurs kunnen opbrengen.

Rik Smits

OVERPEINZINGEN

974



Amerikaans Boeing-postvliegtuig met intrekbaar onderstel

Vorm en functie

NRC 13 FEB. 1999

Van het een komt het ander. Hoe dichter de laatste dag van het jaar nadert, hoe meer mensen verklaren dat ze ons 'het volgende millennium gaan binnenleiden'. Over dit soort eerzuchtige gidsen liep ik na te denken - of nadenken kon je het niet eens noemen. Het was meer zo'n zinnetje dat je bewustzijn in beslag kan nemen. 'Ieder zijn eigen millennium.' Want wie kan, om bescheiden te beginnen, me iets vertellen over de eerste week van de volgende duizend jaar? Het is een slecht argument, dat weet ik, maar tegenover zoveel geblaaskaak schiet me vanzelf zoiets te binnen. Het is geen excuus.

Op straat lag een zwart apparaatje dat er mooi en gaaf uitzag. Ik raapte het op, bekeek het aan alle kanten. Het leek me een soort nietmachientje, maar het 'vloertje' met de twee 'deukjes' waardoor het nietje wordt gebogen nadat het papier is geperforeerd, ontbrak. Na nog eens om me heen te hebben gekeken - misschien was de eigenaar in de buurt maar niemand kwam opdagen - stak ik het in mijn zak om het op de redactie te laten zien en vooral: het te proberen. (De eerlijke vinder zal het onmiddellijk aan de rechtmatige eigenaar teruggeven).

Het was een 'tacker', een apparaat waarmee je papier aan de muur kunt nieten als de muur niet te hard is. Als iets goed werkt, wekt het geestdrift en een verlangen naar meer. De nietjes in de tacker raakten op. En nu bleek dat de nietjes, kaliber 24/6, uit mijn eigen voorraad niet pasten. Wel in de machines van dertig merken die op het doosje staan opgesomd, maar niet in deze T-310 tacker. Die verschiet kaliber 23/6 en 23/8. Ziehier een vraagstuk van het volgende millennium.

Honderdduizenden, misschien wel miljoenen mensen, de hele eerste generatie na de schrijfmachine is opgegroeid met WordPerfect 5.1. Het programma heeft meer mogelijkheden die je niet dan wel nodig hebt, en ook grensmogelijkheden waarvan je later ontdekt dat ze van pas kunnen komen. Maar al met al word je op je wenken bediend nadat je zelf de weg hebt geleerd. Toen kwam Bill Gates met zijn Windows. Ter plaatse heb ik gezien hoe in het eerste uur van het verschijnen de mensen elkaar molesteerden - zonder overdrijving - om een Windows 95 te bemachtigen.

De kennismaking met Windows 95, ook met de reisgids in je hand, is als het gedropt zijn in een oerwoud. Je moet je eigen weg hakken, de verleidingen van de ik weet niet hoeveel lettertypen weerstaan, geen spelletjes doen - kortom alles laten wat je van je werk zou kunnen houden. Dan heeft, voor iemand die alleen schrijft en niets erbij doet, Windows een zekere verdie[nste]
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S. Mon

12 DECEMBER 1998

Hoe ik de Kerst altijd besteed

ım de Kerst schappelijk door te omen gaf ik mijzelf jarenlang vlak oor de feestdagen een cadeau aarvan de installatie nogal wat jd vergt. Het moest een artikel ijn dat mij een alibi bood om niet veral naar toe te hoeven. Langduge studie van een gebruiksaanrijzing was daarvoor een eerste ereiste en de installatie moest ninstens een dag in beslag nemen, efst twee dagen. Daarna verdiep- ik mij in de bediening van het apiraat en vervolgens in de toepassing in de praktijk. Door opzettejk onbegrip wist ik het leerproces e traineren en zo kwam ik soms ook redelijk ongeschonden Oud n Nieuw door.

Goede herinneringen bewaar ik ıan de videorecorder. Om wegwijs e worden moest ik programma's opnemen en kon ik niet weg. Een :d-speler was te simpel en ook een ıntwoordapparaat en een organizer bleken te eenvoudig — al op Tweede Kerstdag waren de geheinen ontmaskerd. Maar een vondst waren de aankopen bij Ikea: tot 2 anuari bleef ik meubels in elkaar zetten. Een magnetron bracht weinig moeilijkheden, maar die had tot voordeel dat ik ermee moest experimenteren.

Het volgende excuus was een laptop met Windows en tegelijkertijd een nieuwe printer. Ze waren al nodig in september, maar ik hield vast aan de traditie van Kerst. Veel plezier heb ik ook beleefd aan een tv-schotel. Deze was niet exact op 19,2 graden oost gericht, waardoor ik meerdere keren het dak op moest om hem opnieuw bij te stellen.

Met de nieuwe fax van de vorige Kerst was ik vele dagen zoet omdat deze hetzelfde nummer heeft als de telefoon. Het antwoordapparaat zat er telkens als stoorzender tussen. De problemen duurden tot Oudjaar.

Voor de komende feestdagen ben ik bezorgd. Ik weet niets meer. Ik wil geen Internet en geen zaktelefoon. Blijft over modelbouw, een aquarium of de slaapkamer schilderen. Misschien gaat er nog wel iets kapot, zodat ik het kan repareren. Of zal ik mij toch weer eens sociaal opstellen?

Vóór het tijdperk van de technologie heb ik tijdens de feestdagen een keer als puzzel de wereldkaart gelegd. Zij nam de continenten voor haar rekening en ik de zeeën. Als ik dit jaar nu eens de continenten doe en zij de zeeën...

JAN EBBINGE

PRIK BORD

En om te stoppen: druk op Start

Bill Gates zei onlangs: „Als General Motors net zo bovenop de techniek had gezeten als de computerindustrie, zouden we nu allemaal in auto's rijden die $ 25 kosten en 250 km rijden op 1 liter brandstof."Hierop antwoordde General Motors met het volgende persbericht: Als GM op dezelfde manier met technologie omging als Microsoft, dan:

Zou uw auto er minstens twee keer per dag zonder aanwijsbare reden mee ophouden. U zou dit gewoon accepteren, de auto herstarten en verder rijden

Zou u elke keer als de verkeerstekens vernieuwd werden, een nieuwe auto moeten kopen

Zouden alle tellers op het dashboard vervangen worden door één display, met daarop twee woorden: *algemene fout*

Zou Apple een auto maken die op zonne-energie liep, vijf keer zo snel was en drie keer zo eenvoudig te bedienen, maar slechts op 5 procent van de wegen worden toegelaten

Zou de airbag eerst vragen: 'Weet u het zeker?' voor hij afging

Zou u bij een GM-auto ook alle wegenkaarten van een bepaald merk moeten kopen, of u dat nu wel of niet nodig had. Als u zonder deze kaarten zou willen rijden, leverde de auto maar 25% van de normale prestaties

Zou maar 1 persoon tegelijk in de auto kunnen plaatsnemen, tenzij hij Car95, Car98 of CarNT heeft. En dan moeten zijn zitplaatsen nog wel apart worden aangeschaft

Zou je bij elke GM-auto opnieuw moeten leren autorijden, omdat niets op dezelfde manier functioneert

En zou je op de START-knop moeten drukken om de motor af te zetten.

Deze anonieme tekst werd ons door verscheidene inzenders toegestuurd. Hij verscheen op Internet, in tijdschriften en opprikborden. Wie weet de oorspronkelijke auteur? En wie weet nog meer van deze anonieme, opmerkelijke teksten? Opsturen naar Achterpagina, NRC Handelsblad. Postbus 8987, 3009 TH Rotterdam. Of naar nrc@nrc.nl

NRC 9 JUNI 1998

TECHNOLOGY REVIEW

Technologie op zichzelf heeft geen waarde, maar wel de toepassing er van. Bij Xerox weten ze er alles van sinds het moment dat een team van antropologen in 1982 met video-opnames aantoonde dat twee gebruikers er een uur lang niet in slaagden om met behulp van de gebruiksaanwijzing een nieuw type kopieerapparaat dubbelzijdige kopieën te laten maken. Toen de opname vertoond werd in de bestuurskamer was de reactie even voorspelbaar als ondoordacht. Het topmanagement noemde de gebruikers technologische onbenullen, tot de antropologen onthulden dat de acteurs in de video-opname twee bekende computerdeskundigen waren.

Vanaf dat moment kon het Palo Alto Research Centre van Xerox geen kwaad meer doen bij het topmanagement, en werd de chef van de onderzoekers, John Seely Brown, opgenomen in de directie. Overigens hadden Brown en zijn mensen voor dat gedenkwaardige moment al een paar uitvindingen gedaan die nu gemeengoed zijn in elk kantoor, zoals de digitale muis, en de laser printer.

In het research-laboratorium van Xerox werken 250 technici en wetenschappers. Het resultaat van de eerder genoemde video-opnames was dat de schriftelijke handleiding met honderden verschillende fout-coderingen bij het apparaat in kwestie plaatsmaakte voor een display waarop precies te zien valt waar zich een mankement voordoet. Op die manier, concludeert het blad zijn de onderzoekers van Xerox er in geslaagd om de barrière tussen research en development te slechten.

Technology Review verschijnt eens per twee maanden.

HERMAN FRIJLINK

CONTEXT:

Maatschappelijk
Wetenschappelijk
Industrieel
Cultureel/kunst

UITGANGSPUNTEN EN THEORIEVORMING:

Context voor ervaren

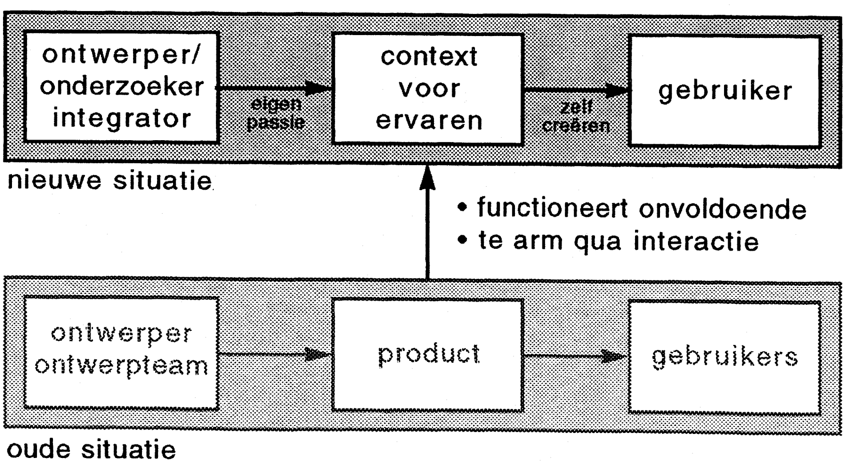
Respect voor de gehele mens
- **fysiek** > **mechanisch wereldbeeld**
- **rationeel**
- **emotioneel** > **emotie in beslissingsproces**

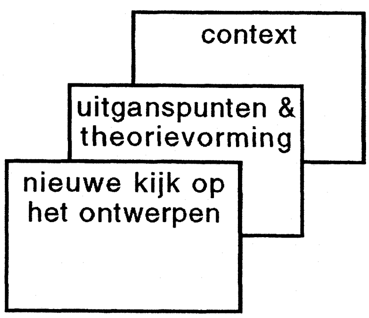
Voorstel aan de gebruiker (libertair)
- **open systeem**
- **diversiteit op belevingsniveau**
- **verleidend**

Esthetiek van de interactie

Universeel versus individueel
- **allemaal mensen, leven in dezelfde wereld**
- **eigen gevoelens en karakteristieken**
- **belevingsprofielen ontwerper <> gebruiker**

NIEUWE KIJK OP HET ONTWERPEN:





De geur van liefde en haat

Caroline Hummels

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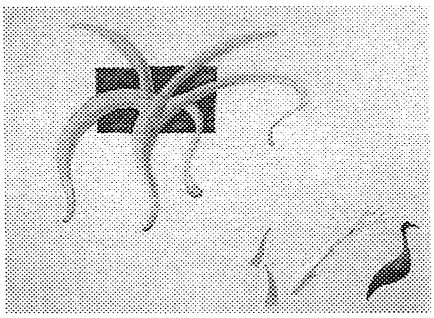
C.C.M.Hummels@io.tudelft.nl
verschijnt in: Geur en ontwerpen: Monografieën over vormgeving

"Het parfum was akelig goed. ... Baldini wenste dat het van hem was, dit 'Amor en Psyche'. Het was geen greintje ordinair. Absoluut klassiek, afgerond en harmonisch was het. En niettemin fascinerend nieuw. Het was fris, maar zonder effectbejag. Het was bloemig, zonder ranzig te zijn. Het bezat diepte, een heerlijke zuigende, verzwelgende, donkerbruine diepte - en was toch geenszins overdadig of zwoel. Baldini stond haast eerbiedig op en hield zijn zakdoek nog eens onder zijn neus. 'Prachtig, prachtig...' mompelde hij en snuffelde gretig, 'het heeft een monter karakter, het is lieflijk, het is als een melodie, het brengt je direct in een goed humeur...'

(Uit 'Het parfum' van P. Süskind, p. 63)

Geuren zijn bijzonder krachtig in het oproepen van sferen en associaties. Associaties die zelfs over de zintuiggrenzen heen kunnen gaan, zoals ook bovenstaande citaat aangeeft. Dit fenomeen wordt synesthesie genoemd, wat volgens de van Dale zoveel wil zeggen als een 'min of meer constante verbinding tussen waarnemingen en voorstellingen uit verschillende zintuigsferen, b.v. het ontvangen van een geluidsindruk bij het zien van kleuren (van Dale, 1984). Deze expressieve, synesthetische kracht van geuren staat centraal in mijn recente experiment, waarin ik studenten heb gevraagd sculpturen en dansen te maken naar aanleiding van een viertal geuren.



Figuur 1: Een sculptuur en een dans gemaakt bij de geur Iso-bornylacetaat.

De komende pagina's hoop ik u de kracht van synesthesie te laten ervaren aan de hand van een aantal voorbeelden en .... de geur zelf!. Voordat ik hier mee begin, zal ik eerst kort de achtergrond schetsen waarom dit experiment heeft plaatsgevonden. Daarna zal ik ingaan op vroeger onderzoek en aangeven wat ik met mijn synesthetische experiment precies wil onderzoeken en hoe ik dit gedaan heb. Ik eindig tot slot met de voorbeelden en de conclusies.

Waarom dit onderzoek: een nieuwe kijk op het ontwerpen

Voor mijn promotie-onderzoek ontwikkel ik een nieuw ontwerp-gereedschap, namelijk gebarend schetsen in de ruimte. De behoefte om deze nieuwe werkwijze te onderzoeken komt voort uit mijn onvrede met het gros van de huidige electronische en computer-gebaseerde producten. Het omgaan met deze produkten lijkt voornamelijk op "weten en leren" gestoeld te zijn. Om bijvoorbeeld een

videorecorder te kunnen bedienen, moet je eerst een dikke handleiding doorploegen Dat is nodig omdat alle fysieke informatie over de bediening weggestopt zit in dat apparaat of in he geheel niet aanwezig is. Is het niet vreemd dat de tape, op zich al een zwarte doos, weggestopt word in een andere 'zwarte doos' waardoor er een display moet worden ontworpen om aan te geven dat e een tape in de recorder zit? Waarom is de tape niet gewoon zichtbaar en kan je niet zien hoever de tape al is doorgespoeld? Hetzelfde geldt voor de verdere bediening van het apparaat. De afstandsbediening is voorzien van tientallen identieke knoppen, waarbij de gebruiker maar moe uitzoeken welke knoppen in welke volgorde hij moet indrukken om een programma op te nemen. He lijkt bijna alsof het bedienen van de videorecorder het einddoel is.
Videorecorders en vele soortgelijke producten negeren dat de mens ook een lijf en emoties heeft Maar juist omdat wij een lijf hebben, kunnen we normaliter zo goed met (mechanische) produkter omgaan. We kunnen om dingen heen lopen, ze vastpakken en gebruiken. Een ouderwetse sinaasappelpers bijvoorbeeld laat zich duidelijk lezen en bedienen: een halve sinaasappel op de pers leggen en vervolgens de hendel overhalen. We begrijpen en gebruiken dit soort mechanische producten onmiddellijk omdat wij zelf een mechanisch systeem zijn en ons wereldbeeld mechanisch is. Electronica echter, dicteert geen specifieke vormen of interacties: alles is maakbaar, met he resultaat dat we "niets meer kunnen maar alleen nog kennen".
Bovendien hebben wij naast een lijf ook nog emoties. Waarom kunnen we geen plezier beleven aar het klaarzetten van de videorecorder om een langverwachte film op te nemen? Eveneens vind ik he vreemd dat producten zoals horloges of auto's in vele kleuren, vormen en maten te verkrijgen zijn terwijl videorecorders, magnetrons etc. voornamelijk verschillen op technische aspecten.
Om te ontsnappen aan deze 'leer&dicteer-machines' stel ik een nieuwe kijk op het ontwerpen voo die uitgaat van de gehele mens: zijn lijf, zijn emoties en zijn ratio. Om deze drie aspecten van de mens te combineren zie ik de ontwerper niet langer als de schepper van producten, maar als de schepper van een 'context voor ervaren'. De nadruk verschuift dus van het product naar de ervaring die je krijgt tijdens het gebruiken van het product. Voor de videorecorder betekent dat eer verschuiving naar (het opnemen om te kunnen) kijken, luisteren, voelen, ruiken, genieten van eer film, documentaire, concert etc.. Om te benadrukken dat deze ervaring verschilt per individu, ste ik het respect voor de (individuele) gebruiker centraal tijdens het ontwerpen en zie ik een ontwerp als een voorstel aan de gebruiker.

Vanuit deze nieuwe kijk op het ontwerpen, stel ik een nieuw ontwerpgereedschap voor dat de ontwerper helpt om deze 'context voor ervaren' te kunnen ontwikkelen. Natuurlijk moet da gereedschap ook de ontwerper als geheel (rationeel, emotioneel en fysiek) respecteren. Gebarend schetsen in 3D heeft volgens mij al deze mogelijkheden in zich. Omdat gebaren dynamisch zijn, kar de ontwerper zich namelijk concentreren op de interactie met het product, op het doen naast he zien. Daarnaast kan hij met gebaren allerlei soorten informatie overbrengen: geometrie, beweging functionaliteit, begrippen & symbolen en niet in de minste plaats expressie. Hij bundelt als he ware de krachten van het schetsen (expressie, ambiguïteit, persoonlijke stijl) met het modelleren (3D en interactie) waarbij hij zijn perceptuele en motorische vaardigheden kan gebruiken er ontwikkelen.

Op papier klinkt gebarend schetsen in 3D misschien aardig, maar hoe is dit in de praktijk te realiseren? Het uitgangspunt 'respect voor de gehele mens', suggereert dat de mens niet gedicteerd wordt door een systeem, maar dat een systeem zich aan de ontwerper aanpast. Om dit te kunnen bereiken, beantwoord ik drie vragen tijdens mijn promotie-onderzoek :

1. Welk soort informatie wordt door de ontwerper gevisualiseerd tijdens de conceptuele fase?
2. Hoe wordt deze informatie vastgelegd door de ontwerper middels gebaren en hoe kan die informatie (door een computer) uit de gebaren worden verkregen?

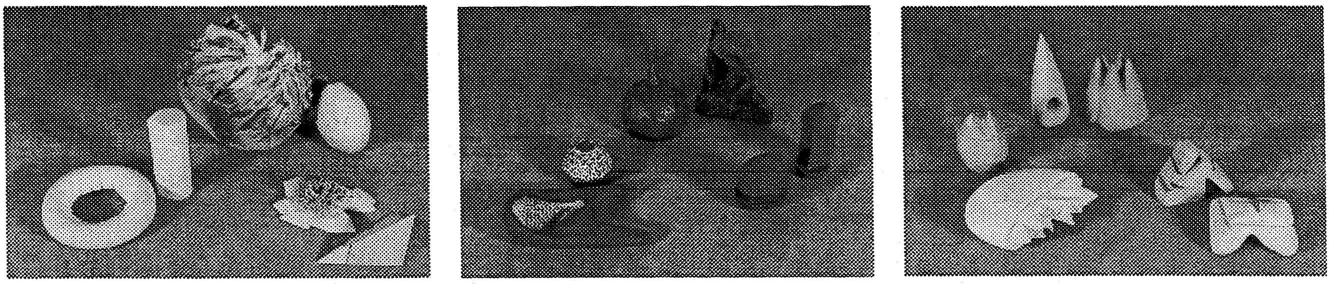
3. Hoe zouden het ontwerpgereedschap en de ontwerpomgeving eruit kunnen zien voor gebarend schetsen?

Ik zal nu alleen ingaan op een deel van vraag 2 ten aanzien van het overdragen van expressie middels gebaren. Voor informatie over de overige delen zie Hummels, Smets & Overbeeke (1998). Dit brengt mij weer bij het begin van deze tekst, te weten de expressieve, synesthetische kracht van geuren.

Wat te onderzoeken: het omzetten van geur naar vorm

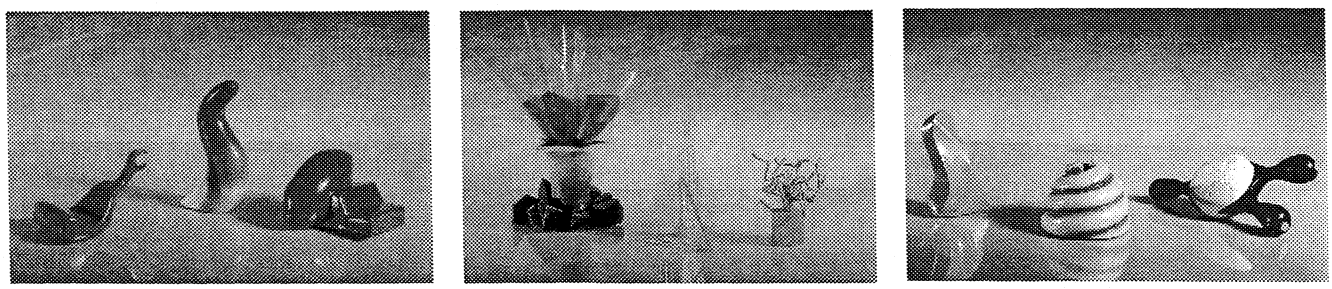
Is het mogelijk om de breedte en kracht van de expressie van producten die ontwerpers nu in schetsen vastleggen, ook middels gebaren vast te leggen? Om dit te testen kan je ontwerpers in de twee situaties (schetsen/gebaren) een product laten ontwerpen, waarvan de expressie meetbaar en te vergelijken is. Uit eerder onderzoek blijkt dat dit mogelijk is door hen een synesthetische opdracht te geven. In mijn experiment laat ik studenten een geur omzetten naar een sculptuur of een dans. Alvorens in te gaan op dit experiment, wil ik eerst kort vroeger onderzoek op dit gebied toelichten.

Voor het practicum Vormtheorie gegeven aan de Faculteit Industrieel Ontwerpen TU Delft, hebben wij vele jaren achtereen de studenten de opdracht gegeven een produkt te ontwerpen dat dezelfde expressie uitstraalt als een aan hen uitgereikte geur, smaak, geluid of muziekstuk. Zij zetten bij wijze van spreken patronen om van de ene zintuigmodaliteit naar een andere.
Tijdens de oefening waarbij de studenten een geur hebben omgezet in een 3D vorm, zijn in totaal negen geuren gebruikt. Als we kijken naar de resultaten, dan blijken er duidelijke vorm- en kleurfamilies te ontstaan rond al deze geuren.



Figuur 2:
De sculpturen die bij één geur gemaakt maken deel uit van een zelfde kleur- en vormfamilie.

Na afloop van het practicum is in een experiment getest of buitenstaanders in staat zijn bij de geur het correcte ontwerp aan te wijzen. Voor dit experiment zijn drie van de negen geuren gebruikt, waarvoor elk drie ontwerpen zijn gekozen.



Figuur 3:
De negen sculpturen die voor het experiment zijn gebruikt.

Elke proefpersoon kreeg deze negen sculpturen te zien, die in toevallige volgorde op een tafel ware geplaatst. Hij kreeg een strookje met één van de drie geuren ter evaluatie aangeboden vergelijkbaar met de strookjes die je in een parfumzaak krijgt om een parfum te ervaren Vervolgens werd de proefpersoon gevraagd om die sculptuur te kiezen die het beste bij de geur paste Deze procedure werd voor de overige twee geuren herhaald. In totaal werden er op deze wijze 1 proefpersonen getest. Van de 45 gegeven antwoorden waren er 35 correct, wat laat zien dat he inderdaad mogelijk is om patronen op te pikken (Smets & Overbeeke, 1989; waar ook ander voorbeelden gegeven worden).

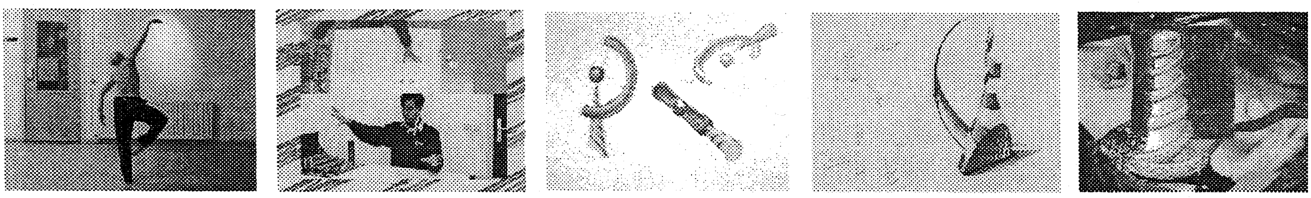
Hoe te onderzoeken: opzet experiment 'de vorm van geur'

Met de wetenschap dat het mogelijk is de expressie te behouden bij het overzetten van een geur i een vorm, heb ik een middel gevonden om mijn vraag te beantwoorden: "Is het mogelijk om d breedte en kracht van de expressie van producten die ontwerpers nu in schetsen vastleggen, oo middels gebaren vast te leggen?" Ik heb dit concreet gedaan door 18 ontwerpers te vragen voor twe geuren een ontwerp van een sculptuur te visualiseren in collages en schetsen. Voor twee ander geuren hebben ze een sculptuur ontworpen middels gebaren in de lucht. Daarbij is hun gevraagd d expressie van de geur te gebruiken in zowel de vorm en kleur van de sculptuur, als in de dynamie van de gebaren. Alle gebarensessies zijn vastgelegd op film. Tijdens een gebarensessie hebben d ontwerpers bovendien de kleur vastgelegd op papier middels potloden, krijt of collages. Om er zeke van te zijn wat de ontwerpers voor ogen hadden tijdens de gebarensessie, werd aan hen na afloo van elke sessie gevraagd ook nog een tekening te maken van de sculptuur. Tot slot heb ik in d experiment gebruik gemaakt van een externe interpretator: zij tekende haar impressie van d sculpturen aan de hand van de gebaren films. Dit is voornamelijk gedaan om te zien of de patrone nog steeds overdraagbaar zijn indien er een schakel aan de keten wordt toegevoegd.

Tijdens deze ontwerpsessies bleken de ontwerpers zeer getraind in tekeningen en collages maken maar natuurlijk veel minder in bewegen en gebaren. Daarom is het experiment uitgebreid me experts in beweging, namelijk 4 dansers die de expressie van de geur in een dans weergaven. Aa hen is niet gevraagd de dans of de kleur te visualiseren in een schets. Wel heeft de interpretator oo aan de hand van deze filmbeelden, de expressie van de dans vertaald in een sculptuur.

Dit leverde in totaal vier soorten stimuli op:

1. filmbeelden van gebarende ontwerpers en dansers
2. tekeningen gemaakt door de ontwerpers van de met gebaren gecreëerde sculptuur
3. tekeningen gemaakt door een interpretator naar aanleiding van de filmbeelden
4. rechtstreeks door de ontwerpers gemaakte tekeningen en collages



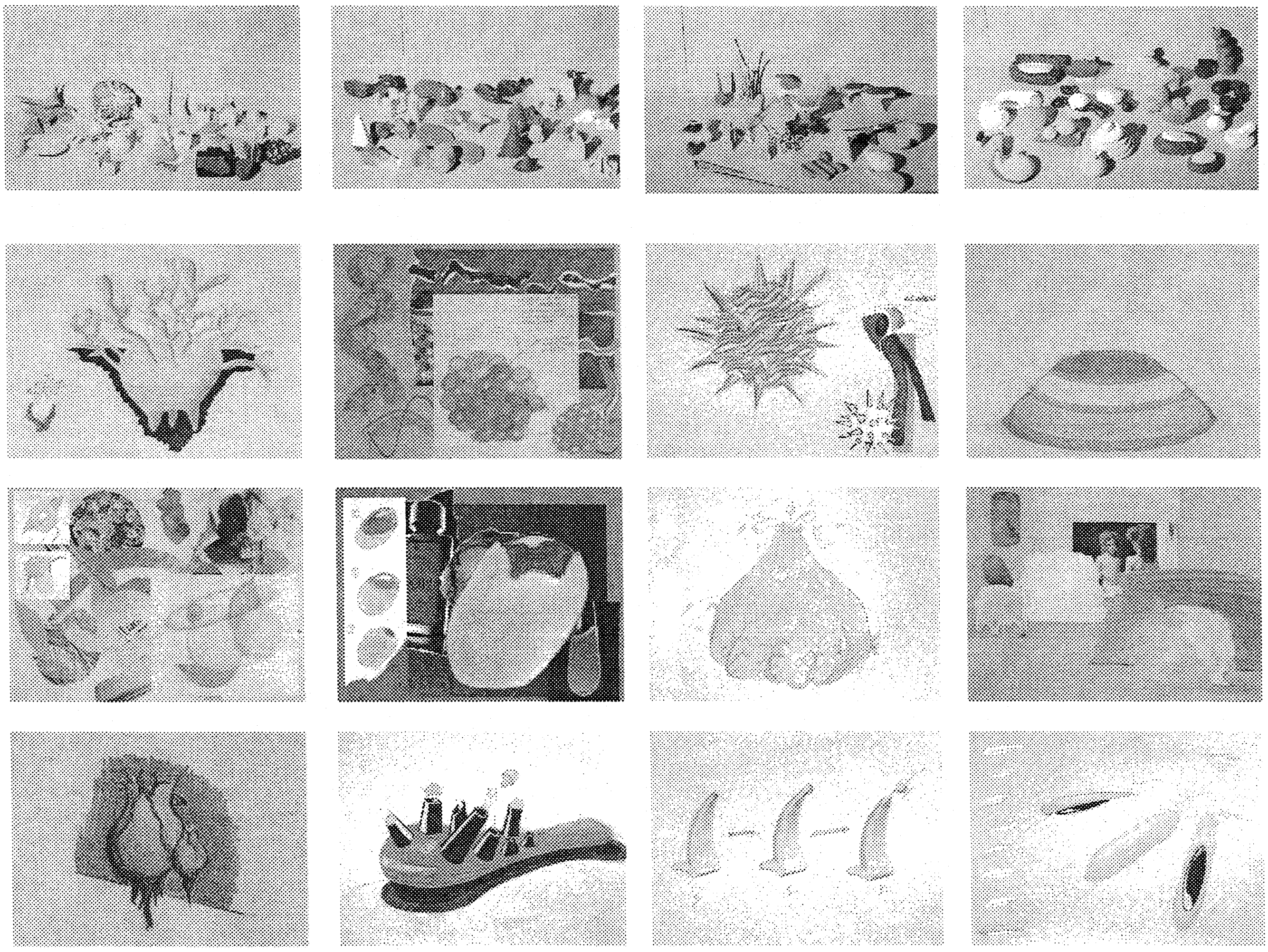
Figuur 4

Er zijn vier soorten stimuli. Van links naar rechts zien we: dansers en gebarende ontwerpers tekeningen van de gebaren door de ontwerper, tekeningen van de gebaren en dansen door d interpretator en tot slot rechtstreeks door de ontwerper gemaakte tekeningen en collages

Voor dit experiment zijn vier van de negen geuren uit het hierboven beschreven experiment gebruikt, namelijk:

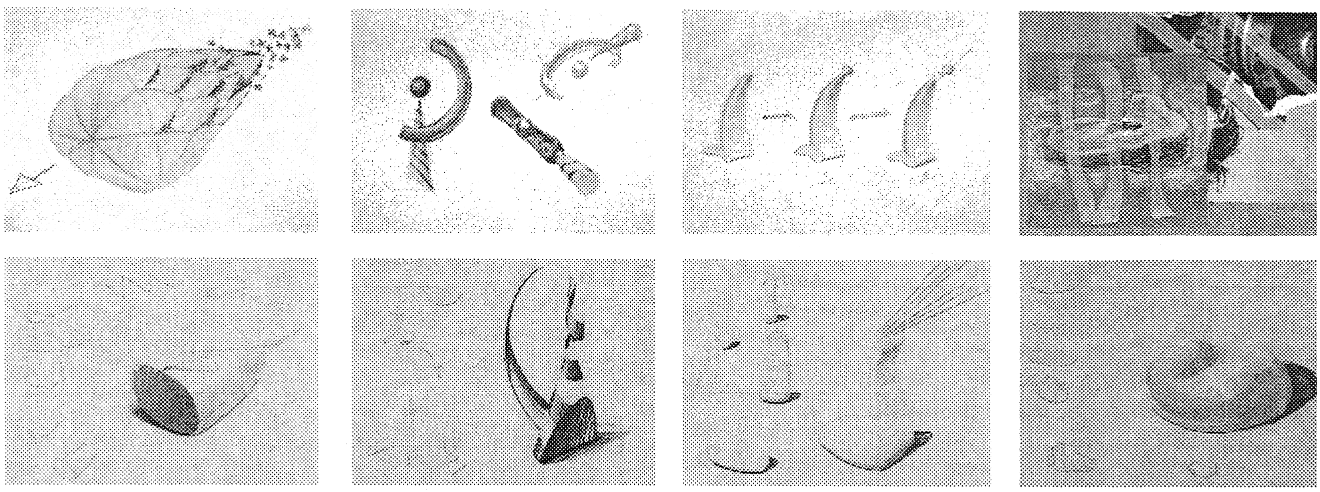
Geur:	*Beschrijving:*
A. ligustral:	groen, geknipte heggeblaadjes, ligusterheg
B iso-amylacetate:	fruitig, zuurtjes, aardbei (de geur is binnen een paar minuten verdwenen)
C iso-bornylacetaat:	dennig, fruitig
D lacton c9 gamma:	fruitig, kokos (de geur is hard in de nageur)

Ook nu zijn er weer duidelijke vorm- en kleurfamilies in de resultaten zichtbaar, al lijkt het voor sommige geuren consistenter dan voor andere. De overeenkomst met de vorige resultaten is vooral voor geur B en D zeer duidelijk.



Figuur 5:
Ook nu ontstaan er kleur- en vormfamilies, vergelijkbaar met het vroegere experiment. Op de bovenste rij staan de sculpturen gemaakt in het vroegere onderzoek. De tekeningen zijn voor dit experiment gemaakt. Van links naar rechts zien we de oude en nieuwe sculpturen die gemaakt zijn voor de geuren a. Ligustral, b. Iso-amylacetate, c. iso-bornylacetaat en d. lacton C9 gamma.

Daarnaast lijken ook de tekeningen van de interpretator op het eerste gezicht goed de expressie te pakken zoals bedoeld door de ontwerper.



Figuur 6

De tekeningen van de interpretator lijken goed de expressie van het orgineel van de ontwerper t pakken. De bovenste tekeningen zijn van de ontwerper, die daaronder van de interpretator. Va links naar rechts: Ligustral, Iso-amylacetate, iso-bornylacetaat en lacton C9 gamma

Om echter te weten of gebaren daadwerkelijk zo krachtig zijn als ik veronderstel, zijn dez stimuli door buitenstaanders getest in een matching-experiment op de computer. Tijdens he experiment werd hen gevraagd de tekeningen van de sculpturen en films met gebarende ontwerper en dansers te beoordelen qua expressie aan de hand van de volgende vraag: "Geeft de getoond sculptuur of dans de expressie weer van de geur die u is uitgereikt? Ofwel, past het getoonde bij d geur?"

Het experiment bestond uit 4 rondes, waarin de proefpersonen telkens een andere geu evalueerden. Het totale aanbod aan stimuli was gelijkelijk verdeeld over deze vier rondes, du evenveel stimuli van elke soort en van elke geur in één ronde en deze stimuli werd bovendien i willekeurige volgorde aangeboden. Tijdens één ronde kregen de proefpersonen achtereenvolgens 3 tekeningen, 9 films van ontwerpers en 4 films van dansers te zien op een monitor. Zij konden vi het toetsenbord de volgende keuze maken:

geeft zeker de geur weer	*geeft waarschijnlijk de geur weer*	*geeft waarschijnlijk niet de geur weer*	*geeft zeker niet de geur weer*

De tekeningen kregen zij maximaal 20 seconden te zien en de films duurden tussen 40 en 60 sec Na afloop van elke ronde werd middels een enquêteformulier gevraagd de indruk van de geur wee te geven op verschillende schalen, zoals plezierig - onplezierig, warm - koud, glad - ruw e bovendien welke kleur(en) de geur opriep.

Omdat tijdens het experiment de kracht van zowel ontwerpers als dansers gebruikt is en h verschil tussen beide groepen ook naar boven kan komen tijdens het matchen, zijn voor h matching-experiment drie categorieën proefpersonen gebruikt: ontwerpers (totaal 18), danser (totaal 12) en diversen (totaal 20).

De resultaten en conclusies: beleving van de gehele mens

Wat verwacht ik nu te vinden? Bij de nieuwe ontwerptheorie staan beleven en ervaren van d individuele mens centraal. Hoe zit het met de beleving in dit experiment? Klopt het dat de belevin van de ontwerper bij een geur slechts ten dele gelijk is aan de beleving van anderen? En is de gehe mens (zijn lijf, zijn emoties en zijn ratio) daadwerkelijk belangrijk bij deze beleving?

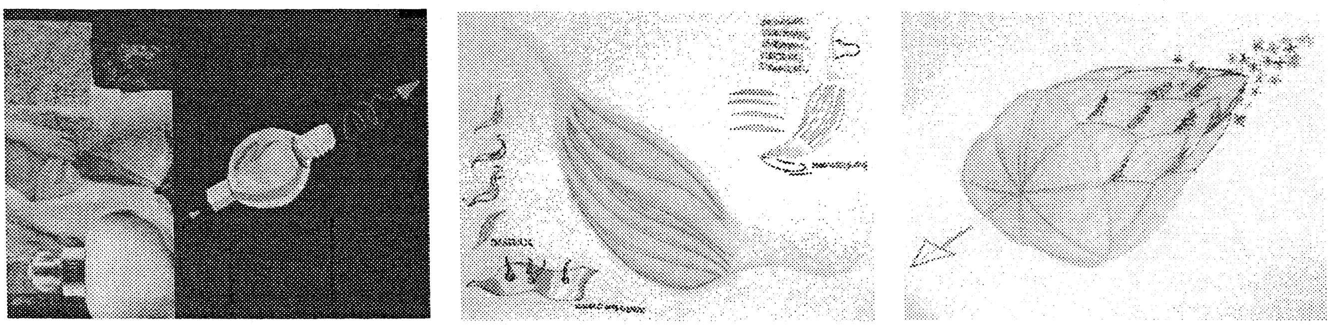
Ik zal aan de hand van voorbeelden duidelijk maken dat beide vooronderstellingen juist blijken: c beleving is slechts ten dele universeel en zowel het lijf als de emotie zijn belangrijk bij deze beleving. Hiervoor gebruik ik de stimuli die gemaakt zijn bij geur A (Ligustral). Om de resultaten aan den lijve te kunnen ondervinden is de geur Ligustral op deze pagina gedrukt. Door nu eerst over figuur 7 te wrijven komt de geur vrij en kunt u associaties vormen bij de geur. Verder zijn helaas de films in deze tekst vervangen door één karakteristieke frame uit de film.

Figuur 7:
De geur Ligustral (helaas in deze print niet aanwezig)

Als ik tijdens dit experiment het over ervaren heb, dan heb ik aan de ene kant over ontwerpers en dansers die de geur ervaren en uitdrukken en aan de andere kant over proefpersonen die de geur ervaren. De ontwerper of de danser legt bij iedere geur zijn emotionele beleving, al dan niet goed, vast in een medium. De proefpersoon kan vervolgens zijn eigen emotionele beleving van de geur matchen met dit medium. Het gaat er dus om dat aan de ene kant de ontwerpers en dansers de emotie in een sculptuur of dans kunnen neerleggen, en of de interpretator dat ook kan vanuit de films. Aan de andere kant gaat het erom of de proefpersonen deze expressiviteit kunnen lezen. Hierbij ligt de nadruk op de wijze waarop die verschillende emoties aan elkaar gekoppeld zijn in relatie tot die expressiviteit.

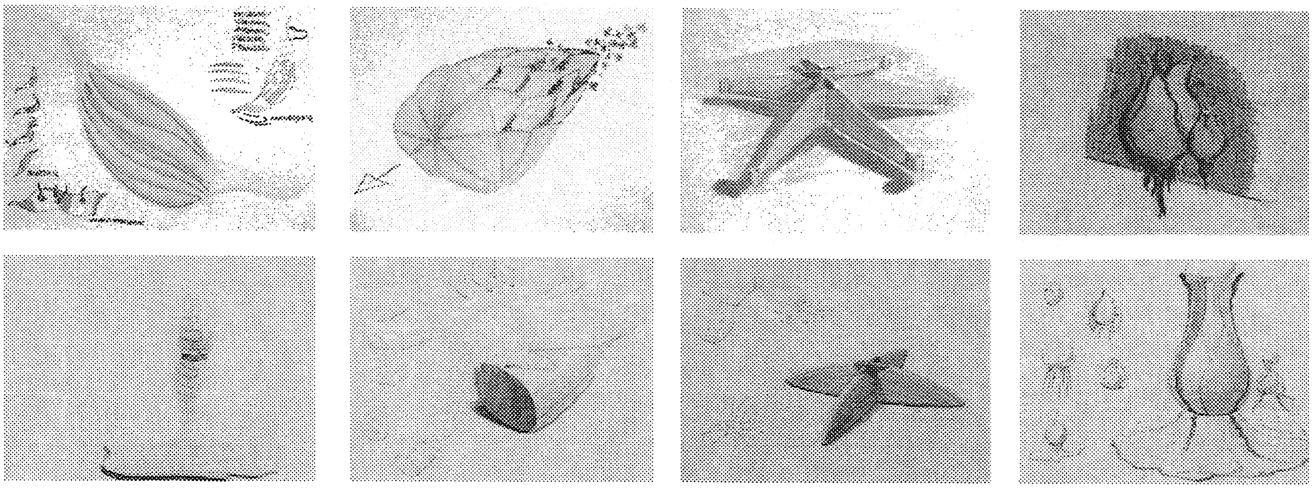
Kan ik nu verwachten dat ik algemene wetmatigheden ga vinden? Tot op zekere hoogte wel omdat wij op een globaal niveau allemaal gelijk zijn: we zijn mensen met een lijf van een bepaalde grootte en opbouw, en met bepaalde mogelijkheden. Bovendien leven we allemaal in dezelfde wereld. Toch gaan die algemene wetmatigheden ook niet op, omdat we individuen zijn met een eigen beleving en eigen lichaamskarakteristieken. Deze overeenkomsten en verschillen spelen in het experiment op twee fronten mee, namelijk bij de makers en bij de proefpersonen. Ik zal aan de hand van voorbeelden deze overeenkomsten en verschillen toelichten.

De beleving is ten dele universeel
Kijk je naar de stimuli die gemaakt zijn bij Ligustral en die procentueel goed scoren in de conditie waarin de proefpersonen Ligustral te ruiken krijgen (boven 60% zegt dat de tekening past bij de geur), dan vertonen de tekeningen duidelijke vorm- en kleurverwantschappen: organische, knolachtige vormen, waarin geel en groen de boventoon voeren.



Figuur 8:
Groen-gelige organische knolachtige vormen die gemaakt zijn bij Ligustral.

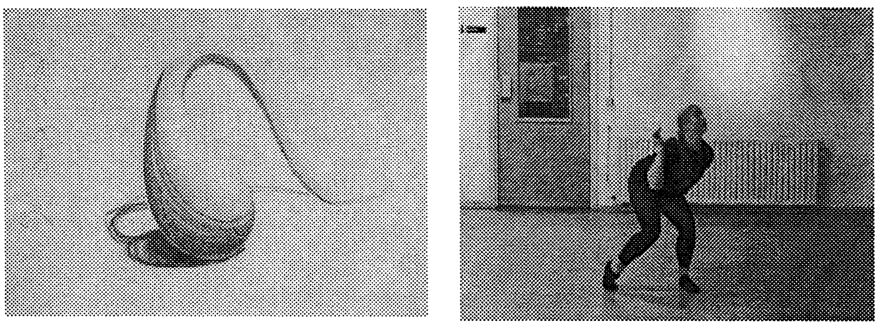
Ook bij tussenkomst van een externe interpretator lijkt het universele deel van de beleving overeind te blijven. Qua vorm en kleur treft de interpretator de essentie van de gebaren veelal goed. Dit blijkt ten eerste uit de vorm- en kleurovereenkomsten tussen de tekening van de ontwerper en de tekening van de interpretator. Ten tweede scoren de stimuli van de interpretator veelal even hoog of zelf hoger dan de originelen.



Figuur 9

De tekeningen van de interpretator scoren veelal even hoog of zelfs hoger dan de originelen van d ontwerper. Boven ziet u de tekeningen van de ontwerper, daaronder staan de tekeningen van d interpretato

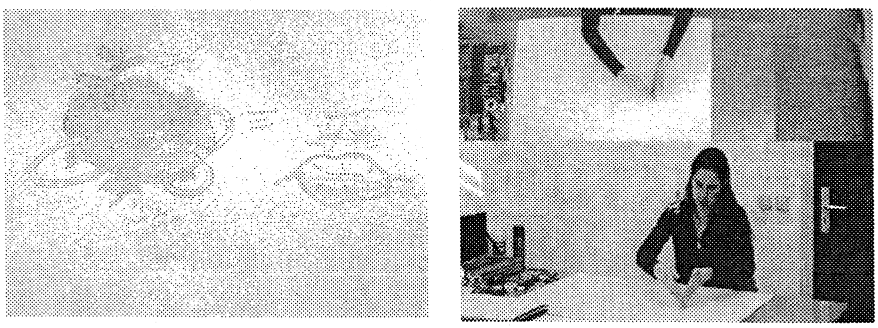
Frappant wordt het zelfs bij de tekening van één van de dansen door de interpretator. Haa impressie, weergegeven in figuur 10 scoort procentueel erg hoog en is overduidelijk vorm- e kleurfamilie van andere sculpturen die hoog scoren. Dat zij deze expressie heeft gehaald uit slecht de bewegingen van de danser (geen kleurindicatie) toont eens te meer de expressieve kracht van on lijf aan.



Figuur 10

De scultuur die interpretac heeft getekend naa aanleiding van één van d dansen, is zeer verwant qu vorm en kleur met de overig goed scorende sculpture

Dus, zowel ten aanzien van de emotionele als de lijfelijke aspecten geldt deze gedeelteli universele beleving. Er bestaat zelfs een tekening en een gebarenfilm van het 'archetype vo Ligustral': procentueel hoge matching voor Ligustral en een lage voor de overige drie geuren.



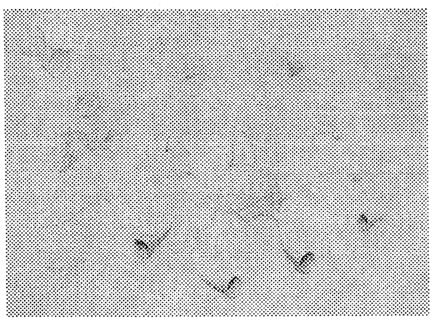
Figuur 1

Het 'archetype' voor de ge Ligustral bestaat in tekenir en gebare

De beleving is ten dele individueel

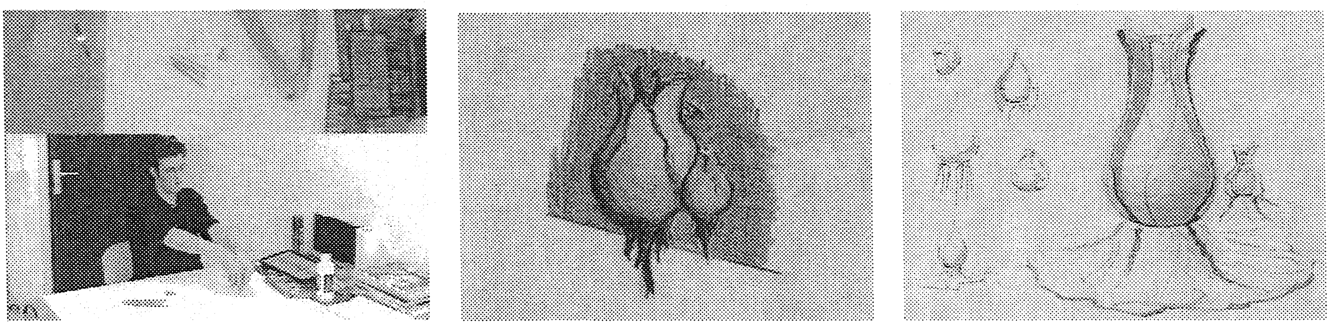
Het individuele aspect van de beleving is mooi te zien middels de emotionele profielen van zowel de ontwerper als de proefpersonen. Niet elke proefpersoon spreekt dezelfde waardering uit voor een geur. Sommige proefpersonen vinden Ligustral plezierig ruiken, anderen vinden het ronduit vies. Deze geur lijkt de geur van liefde en haat.

Er zijn aanwijzingen in de richting dat een correcte herkenning slechts kan plaatsvinden als de ontwerper en de proefpersoon tot eenzelfde emotioneel profiel behoren. Figuur 12 wordt bijvoorbeeld goed gescoord (92% correct) door proefpersonen die de geur gemiddeld neutraal vinden, wat aansluit bij de ontwerper die de sculptuur een heel lichte mate van plezierigheid heeft meegegeven. De sculptuur wordt niet herkend door de proefpersoon die Ligustral bijzonder onplezierig vindt.



Figuur 12:
Deze tekening van een ontwerper die Ligustral heel licht plezierig, wordt correct gematched door de proefpersonen die de geur gemiddeld neutraal vinden. De tekening wordt niet herkend als zijnde Ligustral door de proefpersoon die de geur bijzonder onplezierig vindt.

Maar zo eenvoudig ligt het niet. Bij de driehoeksverhouding ontwerper, interpretator en proefpersoon wordt het complexer. We hadden al gezien dat qua vorm en kleur de interpretator de essentie van de gebaren veelal treft. Kijken we echter naar het emotionele profiel van de ontwerper, van de interpretator en van de proefpersonen die een gebarenfilm herkennen, een tekening van de ontwerper of een tekening van de interpretator herkennen, dan zien we soms verschuivingen. Bijvoorbeeld, de proefpersonen die de tekening in figuur 13 correct matchen, vinden de geur sterk onplezierig. Dit wijkt af van het profiel van de ontwerper (redelijk neutraal), het profiel van de proefpersonen die de gebaren of de tekening van de ontwerper herkennen (beide licht onplezierig) en wijkt zelfs af van het profiel van de interpretator (licht plezierig) ook al heeft zij tijdens het schetsen nooit de geur geroken.



Figuur 14:
Emotionele profielen van de ontwerper en de proefpersonen die de stimuli correct matchen, sluiten niet altijd bij elkaar. De ontwerper vindt in dit geval Ligustral redelijk neutraal. De gebaren (links) en de tekening van de ontwerper (midden) worden correct gematched door proefpersonen die Ligustral licht onplezierig vinden. Echter, de tekening van de interpretator (rechts) wordt correct gematched door proefpersonen die de geur sterk onplezierig vinden.

Dit moment ben ik bezig met de analyse van de gegevens om meer inzicht te krijgen in deze haat-liefde fenomenen. Want tja, het onderscheid tussen haat en liefde is niet altijd even duidelijk.

De toekomst van het ontwerpen

De voorbeelden die hierboven worden getoond geven aan dat de beleving van een persoon, dus zow de ontwerper als de gebruiker, nauw samenhangt met zijn emoties en zijn lijf. De resultate steunen de nieuwe kijk op het ontwerpen. Bovendien geven ze mogelijkheden en openingen voor d ontwerppraktijk

De spanning die bestaat tussen een enigszins universele en enigszins individuele beleving van d gebruiker, geeft aan dat noch 'one size fits all' noch 'solo-solutions' de toekomst hebben. H ontwerpen voor 'profielen' daarentegen zou een breed aanbod aan producten kunnen oplevere voldoende breed om respect te tonen voor alle gebruikers. Deze profielen verschillen met d huidige 'doelgroep' omschrijving, in de zin dat zowel emotionele, als fysieke, als rationele aspecte worden meegenomen. Door de producten vervolgens als een voorstel aan de gebruiker aan te bieder geef je de gebruiker de kans zijn ervaring te realiseren en te ontwikkelen.

De spanning tussen de universele en de individuele beleving bestaat eveneens bij de ontwerper Waarom geen gebruik maken van dit fenomeen? Laat de ontwerper ook zijn emotie en zijn li inbrengen in het product. Bied hen respect en vrijheid binnen het (industriële) bedrijf. Pas da kan de kracht van ontwerpers optimaal benut worden.

Uit de resultaten van het experiment blijkt er een sterke link te bestaan tussen én de beleving va de ontwerper, én zijn motorische vaardigheden, én de expressieve mogelijkheden van zij gereedschap, én de expressie van zijn product. De ontwerpomgeving en de ontwerpgereedschappe zeker de computer-gebaseerde, zouden deze link heel bewust moeten ondersteunen, omdat bij h ontbreken van één van de vier aspecten het hele bouwwerk kan instorten en de ontwerper niet mee in staat is om tot de essentie door te dringen.

Beweging, gebaren, interactie gaan uit van de dynamiek van het lijf en zijn gericht op de dynamie van het gebruik van producten. Dit experiment tilt slechts een tipje van de sluier op ten aanzie van deze aspecten, maar laat wel het potentieel van het lijf en lijfelijke expressie zien. Zou het ni mooi zijn dat ontwerpers zich op de esthetiek van de interactie gaan richten als aanvulling op d esthetiek van de vorm? De esthetiek van de interactie zou zich niet alleen moeten afspelen op h vlak van de gebruiker tijdens de interactie met het product, maar ook op het vlak van d ontwerper tijdens het ontwerpen van de interactie. Bij het centraal stellen van beweging en d esthetiek van de interactie is het wenselijk dat ontwerpers ook in deze aspecten getraind worden. Tot slot, gaat dit hele verhaal over ervaren in de breedste zin van het woord. Een heel boek ove ontwerpen en geur is mijns inziens een mooie stap op de weg naar een rijke context voor ervare

Dankwoord

Graag wil ik Kees Overbeeke bedanken voor zijn inzicht en enthousiasme bij het bewandelen van d hobbelige weg van onderzoeken en teksten schrijven. Tevens gaat mijn dank uit naar Gerda Smet Stephan Wensveen, Tom Djajadiningrat en de overige mederwerkers van de sectie Vormtheori zonder wie mijn onderzoek nooit had kunnen plaatsvinden.

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Let the body in

On the relationship between form giving and usability

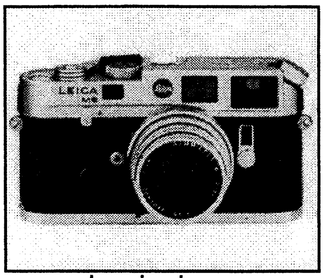
J.P. Djajadiningrat and C.J. Overbeeke

Summary

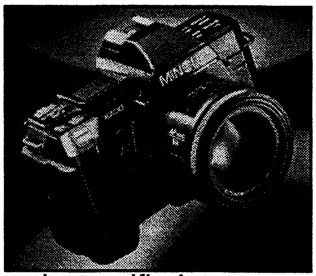
In this paper we investigate the influence of formgiving on human-product interaction (HPI). The current tendency to hide components from the user by putting them in a sealed box, and then design an interface to restore communication between the user and those components, is criticised. To arrive at a form giving which does allow intuitive interaction, we argue the value of Gibson's theory of affordances. The objective is to investigate whether and if so how industrial designers can make use of the theory of affordances on a practical level to improve the usability of products. We start with why human-product interaction has become a pressing issue in product design in recent years, illustrated along the hand of developments in photographic cameras. Next we explain affordances and how they fit within the theory of direct perception. The relevance of affordances for solving the aforementioned interface issues is described. We then give an overview of established 'good practice' in HPI in order to clarify what affordances have to offer in addition to existing practice in HPI. Particular attention is given to the field of product semantics, which we consider to be part of established practice in HPI. We then compare product semantics to affordances in terms of what they mean on a practical, designers level rather than by the theories from which they originated. Through this comparison we attempt to highlight the benefits and shortcomings of these two approaches for industrial designers and how they might complement each other. We then try to show by means of an example how an affordance conscious design approach can differ from existing good practice and how it can improve human-product interaction.

Human-product interaction - a pressing issue

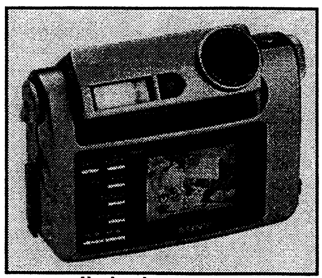
An important aspect of product design is to make clear to the user how to operate a product. No matter how well the product performs from a technical point of view, its technical functionality is limited to that which the user can actually access. For example, Van Nes and Van Itegem (1990) show how users are not aware of much of the functionality which earns a particular car radio the label 'advanced'. In the past the mechanical workings of a product largely dictated the overall form and the positioning of the controls. The advent of microelectronics and miniaturized mechatronic components, did not only enable designers and engineers to create products that were smaller than their mechanical counterparts, but also gave them much more freedom for the overall form and layout of components and controls.



mechanical camera
(Leica M6)



electronified camera
(Minolta 7000)



digital camera
(Sony DSC-F1)

Figure 1: Development of photographic cameras

Take for example the way in which photographic cameras developed. The form of a mechanical camera was largely dictated by the mechanical transport of the film, a lens which needed to be perpendicular to the film plane and the path from the lens to the viewfinder. The viewfinder needed to point in the same direction as the lens in the case of a 'view through' camera or needed to be connected with a minimum of prisms and mirrors in the case of a single lens reflex camera. With distance, aperture and shutter speed controls, early mechanical cameras featured only a minimum of functions (Figure 1).

In the eighties these mechanical cameras became increasingly electronified and acquired more functions. However, the camera's overall size and layout did not change much as these remained dictated by mechanical components (Figure 1).

With the advent of modern digital cameras, of which the most important components were a recording CCD, a solid state storage device and a LCD screen as a view finder, constraints on the form became far less strict as connections between the components were electronic rather than mechanical (Figure 1). With the digital camera the number of functions increased once again, not only when compared to the mechanical camera but also when compared to the electronically controlled camera. Added features included in-camera image manipulation and computer, printer and television interfaces. Though early digital cameras were similar in size to their mechanically based ancestors, they paved the way for smaller products as their electronic components were easier to miniaturize than mechanical components such as film transport.

In the process from fully mechanical to fully digital the camera gave less and less auditive and haptic feedback. The introduction of electronic zoom and shutter release button impaired the feel of the camera. With the digital camera even the sound of film advancement after each exposure disappeared.

Many other consumer products went through or are going through the same process as the photographic camera described above. Though certain controls could be eliminated through automation, this did not weigh up against the controls which spawned from additional functionality. More functions needed to be packed in a smaller housing which offered less room for controls. Feedback was reduced as electronic parts - unlike mechanical components - do not provide meaningful auditive feedback and because electronic controls offer less haptic feedback than mechanical ones. Moreover, interface designs became increasingly modal: depending upon which mode the device was in, a control had a different function. As the 'functions to controls ratio' increased descriptive labelling of controls became difficult. The feedback which disappeared from the controls themselves was partly taken over by electronic displays. Thus human-product interaction became more like human-computer interaction.

Increased functionality and miniaturisation increased the importance of user interface design. Also, as the production quality of most current products is beyond doubt and products are difficult to distinguish on their technical merits, user interface design is becoming more of a sales argument.

HPI would benefit from a theoretical framework to tackle the aforementioned issues. The theory of affordances can act as such a framework. In the next section we describe how affordances fit within the theory of direct perception and how they are interpreted in this thesis.

Affordances and the theory of direct perception

Affordances form part of the theory of direct perception, also known as the ecological approach. This theory of perception was started by J.J. Gibson (1904-1979). Central to this perception theory is the reciprocal relationship between animal and environment. Having gone through evolution together animal and environment are thought of as inseparable, with one implying the other. As in industrial design we generally design for humans, in this chapter we will talk of man and his environment, rather than animal and environment.

Gibson thought up the neologism 'affordance' as a noun to complement the verb 'afford'. "The affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill" (Gibson, 1986). In keeping with the notion of the inseparability of the man-environment system affordances can only be thought of in terms of such a system as a whole, not just in terms of man only or the environment only. It may be clear that affordances cannot be thought of as separate from the environment. Yet it may be less obvious that neither can affordances be thought of as being separate from man. There are two main reasons why affordances of products cannot be seen as separate from man. First, affordances have to be specified in terms of information which a human individual's perceptual system is capable of detecting. Second, properties which specify an affordance are not meaningful when measured in physical terms but only when specified relative to a human individual. What the environment affords depends on whether the human is a child or an adult (body scale), frail or in perfect health (body condition). To a child the railings of a fence may afford squeezing through, while to an adult they do not. To a fit person a puddle may afford jumping over while to a granny it may not. To capture the capabilities and limits of both someone's perceptual systems and his motor systems in one conception we can speak of someone's perceptual-motor skills.

However, affordances are not only inextricably linked to the behaviour a human is capable of, but also to his intentions. The total of these potential purposeful behaviours are called a human's effectivities (Shaw & MacIntyre, 1974; after von Neumann, 1966).

Another idea which is essential to the theory of affordances is the inseparability of perception and action. Perception is seen as written in the language of actions. Structured energy only forms information for a human if that human can act on it. In other words, perception is only of use if it leads to appropriate action. Likewise, action can only be successful if it is guided by appropriate perception.

Furthermore, affordances are more than just properties perceived which specify possible or permitted actions. Affordances also specify the details of those actions (Michaels and Carello, 1981). A playing ball affords throwing but different types of balls afford throwing in different ways.

What can the theory of affordances contribute to HPI? In order to answer that question, we first need to look at current 'good practice' in interface design. Only then can we say which parts of current HPI are consolidated by the theory of affordances and what news affordances could bring.

Current 'good practice' in interface design

What follows is a list of points which are generally considered 'good practice' in HPI. It should be viewed as points that interface designers are aware of. 'Good practice' does not mean that these points are always considered in practice. Many products on the market violate one or more of these points. During the design process these point of 'good practice' may get sacrificed as compromises are made.

Furthermore, this list focuses mainly on interface design of electronic consumer products. Therefore, much attention is given to controls and displays. This list does not address such issues as dimensions and layout of interior spaces, despite the fact that usability of consumer products (product design) is influenced by the way they are integrated into our environment (interior design and architecture).

This overview does not pretend completeness. we feel, however, that it is necessary to give some ideas about what is generally considered 'good practice' in interface design, as often designers discard affordances as 'old hat under a new name'. Having composed a list of ingredients of 'good practice' we will use it to dispel the view that the benefits the theory of affordance can bring to interface design are already present in a product in which the current ideas about HPI are well implemented.

Anthropometrics

The field of anthropometrics is concerned with the measurements of the human body. Measurements which can be used in the optimisation of products and our environment. The field of anthropometrics therefore forms an essential ingredient for the improvement of product usability.

When designing a product for usability it is a prerequisite that the product's size and the sizes and spacing of its controls are in keeping with the dimensions of the human body. An example of how neglect of anthropometrics may negatively effect usability are the miniature buttons of the calculator on a digital watch as their physical size is not tuned to the size of a human finger.

Expressing the purpose of a product

Expressing the purpose of a product as a whole is the first step to intuitive operation. Once it is clear to the user what kind of product he is dealing with, his pattern of expectation with regard to the purpose of the controls is adapted to the purpose of that product. For example, if a user does not recognize an escape hatch, or fire extinguisher, or any piece of safety equipment for what it is, the device may never invite intuitive use no matter how well designed its controls. A less life threatening but nevertheless still very annoying example is when the new owner of a set of audio equipment tries to operate the CD player, only to find out that the component he is dealing with is not the CD player but the highly similar looking pre-amplifier (Figure 2). Often components are designed to look identical. According to Dondis (1973): "Repetition is the uninterrupted visual connections that are particularly important to any unitised visual statement". From a usability point of view, repetition is an easy way of achieving an aesthetically pleasing whole, for which the expression of the individual components is sacrificed.

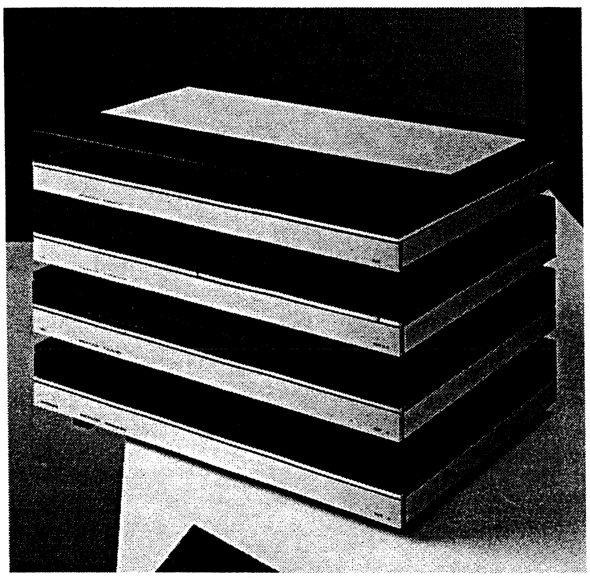


Figure 2: Highly similar looking audio components (Bang & Olufsen Beosystem 5500)

Grouping of controls

Thoughtful product design does not only consider anthropometric aspects of controls, but also the way controls are grouped. By clustering controls according to their functionality or to the way in which they are used, an interface can be made more clear-cut. Through the drawing of arrows on a control panel Mayall (1968) shows how a visually well ordered arrangement of controls turns out to

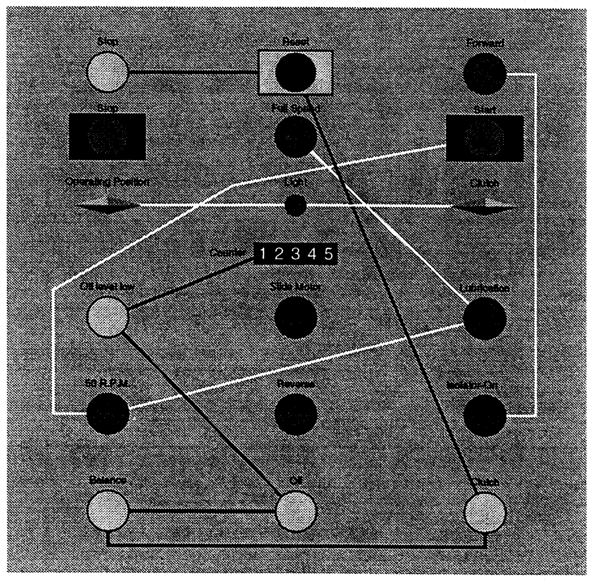


Figure 3: Visually well-ordered, disordered in use (after Mayall (1968), page 53)

be thoroughly disordered in use (Figure 3).

Grouping should also take into consideration limitations of the human anatomy. Frequently used controls should demand a minimum of physical strain.

Importance of controls

Indicating a hierarchy of importance in controls can improve usability. The importance of a control may be expressed through form, colour, texture and material. Note that the importance of a control is not necessarily related to frequency of use. The recording button on audio/video equipment is given special status not because it is used the most often but because it may cause an irreversible process.

Differentiation between controls

Controls should distinguish themselves from each other. This can be achieved through form, colour, texture and material. For cost or aesthetic reasons controls often violate this principle, thus becoming difficult to tell apart except for through their labelling. As with the similar looking system components under 'expressing the purpose of a product', here too repetition is used to create unity. Products result which at first appear to be clear-cut through their rigorously organized control panels but which often turn out to be still confusing when it comes to activating a particular function within a particular group.

Controls which express what action operates them

Controls should express how they need to be operated. It should be clear that a particular control needs to be rotated and not pressed, or that it needs to be slid and not tumbled. If controls are formed the same, the user will expect that their mechanical behaviour is identical. An example of a device with such controls is that of an amplifier of which the front panel shows three identical looking rotary controls. Yet the volume control allows continuous rotation over 270 degrees increasing clockwise, the balance control allows continuous rotation over 180 degrees symmetrical to the neutral vertical position, while the input selector offers rotation in discrete, notching steps only. If the actual mechanical behaviour of the control is different from the control's behaviour as expected by the user, fluid interaction is hampered.

Controls which express how the action which operates them is to be carried out

Once a control expresses what action is needed to operate it, i.e. pushing, sliding, turning etc., for fluid interaction it is also necessary to consider the expression of how that action is to be carried out. For example, both the on/off button of a radio and the emergency stop of a lathe may afford pushing, yet the way in which they should be pushed are completely different. A control needs to express how much bodily interaction is to be involved: finger tip, one finger, multiple fingers, a whole hand etc. If a control expresses the wrong 'how' it may either not be activated or suffer excessive wear or even damage. If controls are optimized for a certain hand position then the device needs to express this, otherwise it may never be used in the intended, optimal fashion.

Fitting the control to the nature of the variable

A control should fit the nature of the variable which is to be adjusted. As a negative example, in many electronic products continuous variables (sound volume, time, temperature) are adjusted in discrete steps by means of up/down buttons. Such buttons reflect neither the continuous nature of the variable, nor the fact that there are limits to adjustment of the variable. Up/down buttons result either in waiting to achieve the right setting or in overshoot. To compensate for these shortcoming in comparison with, for example, a marked rotary control the up/down buttons need to be accompanied by some kind of electronic display.

Mapping

The way controls are laid out can have a great influence on how easy it is to operate a product. One form of mapping deals with how the controls map to what is being controlled. Norman (1988) gives the example of a four ring cooker and how the spatial relationship between the controls and the rings influences the cognitive burden on the user. While in all of the concepts presented the same controls and rings are used, because of the layout they differ significantly in how much knowledge the user needs to operate the correct control.

Another form of mapping considers how the movement of a control maps to movements on a display. When it is not possible to achieve natural mapping between control and display, considering their relative placement may help in minimizing error. An example is mapping of a rotary control to a pointer on a linear vertical scale. Brebner and Sandow (1976) and Petropoulos and Brebner (1981) show how the relative positions of the control and the display significantly influence consensus among subjects on how they expect the direction of rotation to influence pointer movement.

Feedback

In order to give users a sense of control a product should give feedback clearly indicating its current state or the execution of a process. Feedback gives the user information about the result of the user's actions. Without such feedback the user remains in doubt whether the device is responding or not. As was noted in the example of the development of electronic cameras the use of more electronic components and less mechanical ones often leads to impoverished feedback. As Norman (1992) says: "Mechanical devices are often visible and audible, conveying considerable information about their operation, even to those who know nothing of mechanics. The designers do not have to provide feedback to the users. The very nature of the machine guarantees that.". In addition to the visual and auditive feedback mentioned, mechanical objects offer natural haptic feedback. Natural haptic feedback offered by mechanical buttons is eliminated when electronic touch controls are used instead. Products which do not give any feedback regarding their current configuration or state are rare. There are, however, many products which give very little feedback. With video recorders and CD players for example it may take studying of the display to see whether a tape or disc is in the machine. It is not that it is impossible to see whether a tape or disk is present, it is just that it is made unnecessarily difficult as it is often indicated by tiny characters or icons on an electronic display.

Expressing the purpose of a control and making the result of an action perceivable

Even though a product may satisfy the previous points of 'good practice' with regard to its controls, the controls may still not express what they are for and what operating them leads to. A control may have an anthropometrically correct size, be placed in the correct group, express its relevance relative to others controls, differentiate itself from other controls, express what action is required and how this action is to be carried out. It may also fit the nature of the variable it controls, be mapped correctly and offer feedback. Yet the control may fail to express what its purpose is. Clearly, this expression is essential for usability as it allows the user to pick out the control that is required to fulfil the task he has in mind. Expressing the purpose of a control is highly related to the previously mentioned 'differentiation between controls'. In order to express its purpose, a control needs to differentiate itself from other controls. Still, merely being different is not sufficient, the control needs to express its specific purpose. In other words, it needs to communicate to the user what the result of operating it will be.

Product semantics

Product semantics is a design movement which attracted much interest in the second half of the eighties. In this section, we first turn to the theoretical background behind product semantics. Second, we give some concrete examples, and point out the shortcomings and potential of product semantics with a view to usability. Third, some design methodologies which resulted from product semantics are described.

Theoretical background of product semantics

Krippendorff and Butter (1984) say: "product semantics is the study of the symbolic qualities of man-made forms in the context of their use and the application of this knowledge to industrial design".

They present product semantics as a design theory which draws upon a mixture of semiotics and information theory.

In semiotics the central concept is the sign. Semiotics revolves around how meanings match or differ as these signs are created and exchanged between people. The sign is intended to represent something, though what is actually expressed to a user may be different. Different instead of matching meanings are not necessarily seen as undesirable 'miscommunication' but more as a potential 'richness', which shows important sociocultural differences between people (Byrne, 1990). Examples of semiotic analysis applicable to industrial design are Barthes' (1972) essays 'The New Citroën' and 'Toys'.

In accordance with information theory, in product semantics the designer is viewed as a communicator of a message in the form of a product and the user as the receiver of that message. The designer can only send the message once while the user reinterprets the message again and again through its use. The encoding of the meanings of a product is influenced by the designers competence and vocabulary, his socio-cultural background, his intentions and condition. The decoding of the meaning of a product on the side of the user is influenced in a similar fashion. Technical or economic compromises in the production process introduce 'noise' as the message is sent from designer to user.

The use of metaphor examined from a usability point of view

At a concrete level, product semantics often seems to work via metaphors and association. This is particularly well illustrated by conceptual work created at the Cranbrook School of Art and Design, where product semantics was the central theme in the eighties (Aldersey-Williams et al., 1990). Products resulted which tried to convey meaning through the use of metaphor. Metaphor can be used in various ways. First, it can be used to draw upon an existing language of forms from another field of interest, in order to position the product as being related to that field. Second, metaphor may go beyond a merely visual relationship, to express a relationship in functionality with an existing product or concept. Third, a product may be associated with an existing object or concept, natural or man-made, to convey that it has characteristics present in that object or concept. We will now give some examples of these forms of metaphor.

An example of a product which borrows from existing design languages is the audio receiver shown in Figure 4. It draws upon forms which are used for musical notation and for traditional musical instruments. This does not mean that the receiver can used for musical notation or that it is an instrument. The design of the receiver draws upon existing visual languages to express that it fits within a category of objects which have to do with music.While the metaphors of musical notation and traditional musical instruments have given rise to a visually interesting way of organizing the receiver's control surface, they have offered very little help in distinguishing the controls themselves. Apart from the volume control, which has been given a clear direction by the increasing size of the buttons, all the controls are buttons identical in form, texture and colour.

Some forms of product semantics may give rise to a new form language, yet do not help to clarify what the product is for. This may be the case when Uri Friedländer (1984) states: "... we now face the problem that metaphors are difficult to relate to shapes that are not sensed by most consumers: The abstraction of the electrons. Thus, we are forced to use the mound which houses these particles for the creation of a new metaphor: the chip. Sharp edges, dark boxes, sensitively detailed large flat areas interrupted by slim lines: These are the new abstract metaphors of advanced technology." While developing such a design language may be useful in breaking with a particular aesthetic tradition, it does

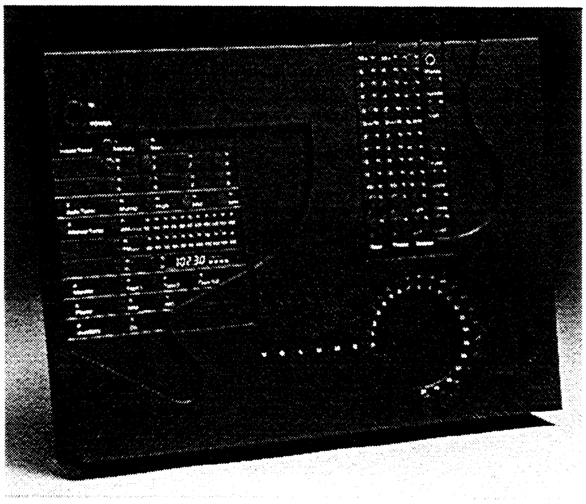


Figure 4: Concept for audio receiver drawing upon forms in musical notation and of traditional instruments (design: Robert Nakata, 1985)

not help the user in distinguishing different electronically based products and giving these an identity of their own.

An example of the use of metaphor to express a relationship in functionality is shown in Figure 5. It is a conceptual model for a portable microwave oven which is form given as a traditional workman's lunchpail. Styling cues hint that since there is a relationship in form, the user can expect func-

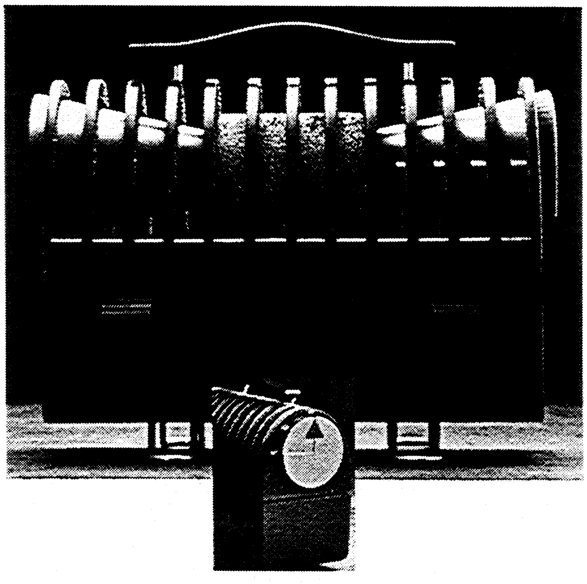


Figure 5: Concept for portable microwave oven reminiscing an American workman's lunchpail (design: Paul Montgomery, 1986)

tionality which is highly related. Both are food containers used during lunch, and both are portable.

We now turn to examples of products which use metaphor to express that they have characteristics in common with another object or concept, natural or man-made. For example, the curvi-linear forms of Art Nouveau lamps and fences draw upon those of flowers and trees. Likewise, the organic forms of some cars might be associated with the muscles of feline predators. However, generally this type of metaphor is used to shape the expressivity of the product as a whole, not to improve usability. Potentially though, this subtle application of metaphor could be used to improve usability. For example, a control could express that it needs to be treated with gentle care, like an egg. This requires much sensitivity on the part of the designer. It is not possible to use a literal copy of the egg as a control since the control generally needs to express more than just vulnerability, and since the form may be undesirable for aesthetic, ergonomic or technical reasons. Therefore only the aspects of an egg which express vulnerability need to be copied to the control. What is it that makes an egg vulnerable? Is it its form, or perhaps its crackle texture? Or perhaps an egg does not express vulnerability at all, we may simply have learned that it is vulnerable, in which case another association is needed.

There are a number of drawbacks to the metaphoric approach of form semantics. Gentner and Nielsen (1996) name three problems with functional metaphors which compare a novel product to an existing product. They illustrate these problems by means of the 'a word processor is like a type writer' metaphor. The first problem is that at some point the metaphor will break down. The newly designed product may have more functions than the concept it is associated with has to offer. Based on the aforementioned metaphor the user of a word processor would never look for the replace command. The metaphor stresses the similarities of an electronic product with a traditional product, rather than its innovative qualities. The second problem is that the new product may not (yet) have the features of that which it is compared to. While a type writer allows you to mark up any piece of paper you get in the mail, a word processor by itself does not offer that functionality. The third problem is that some features exist in both the new product and the old one which it is compared to yet work completely differently. In the case of the word processor-type writer metaphor such features include tabs and line feeds.

Gentner and Nielsen also give an example of an interface which faithfully emulates the interface of an earlier technology. The Phelps tractor (Clymer, 1950) is a steam-engined vehicle from 1901, which is controlled by reins (Figure 6). It thus draws upon a metaphor with the interface for the familiar horse. Drawing the reins causes the vehicle to brake until it reaches a standstill. When the user continues to draw the reins at standstill, the vehicle will back up. Giving free rein will cause the vehicle to accelerate.

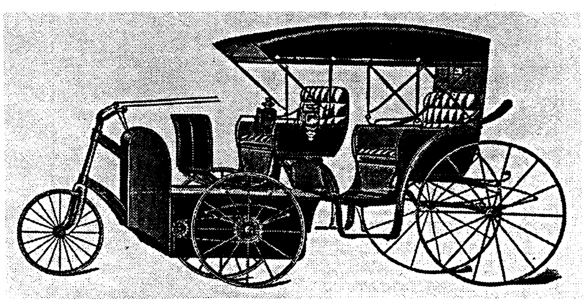


Figure 6: The Phelps tractor, a steam powered vehicle from 1901 which is controlled through reins.

Summarising, if the metaphor is made highly concrete then its explanatory quality will be limited, as users will only expect the functionality of the object or concept it is compared to. Also, a highly concrete metaphor based on earlier technology, as in the Phelps tractor, may not lead to the most appropriate interface for the new product. On the other hand, if the metaphor is very much abstracted, users may not catch the reference and cannot draw upon their experience with the obscurely referenced object.

Gaver (personal communication) points out that collapse of the metaphor is unavoidable and a natural part of the maturation of a new product. It is not until the metaphor dies that a thing gets meaning for itself.

Design methodologies based on product semantics

There are several examples of design methodologies based on product semantics. Friedländer (1989) illustrates the design process of a espresso-machine, which emphasizes the ceremonial values of coffee making. By studying existing objects with ritual or religious values he discovers recurring elements in those objects which he reuses in the design of the espresso-machine.

Lannoch and Lannoch (1987) developed a method which they call 'semantic transfer'. In this method the desirable characteristics of a product are first expressed in words. These words are then considered in all their possible contexts. Through this process the designer can build up a range of possible associations to arrive at a physical artifact.

Byrne (1990) gives an example of a working method based on semantics for the design of a brandmark. Through analysis of the facts about the company, its purpose and the goals of its brandmark redesign, a denotative word list is built. Visualisations of these words are put in a matrix in which they are narrowed down through combination after which a brandmark appears. The outcomes of several of the matrices are tested against a connotative word list forming a semantic differential scale.

The usefulness of affordances for human-product interaction

When comparing the description of affordances to the list of good practice in interface design it becomes evident that affordances form an elegant frame work to unify apparently disparate elements of HPI. The need to consider the interaction of the acting-perceiving human and his environment is reflected in the anthropometrist's concern with body dimensions and the ergonomist's interest in the relationship between human abilities and the design of the environment. Objects may be too large or too heavy to invite certain actions. Two vessels may be identical in form and colour, yet only one invites drinking from as the other is too large to hold, making it a vase.

Showing the possible behaviour the user can enter into is improved by clear expression of a product's functionality and what actions are required by its controls. A control which not only shows the required action but also how that action is to be carried out, is in keeping with Michaels' and Carello's (1981) assertion that affordances specify both the global aspects and the details of an action. The haptic feedback which is naturally present in mechanical components but so often lacking in electronic products was emphasized by Gibson (1986) in his example of the affordances of a pair of scissors in which "one can actually feel the cutting action of the blades".

Affordances may offer interface design another interesting opportunity for reflection in that Gibson's definition ends with 'for good or ill'. When thinking in terms of human-product interface design this leads to a distinction between affordances which invite effective action leading to the result desired by the user, and affordances which invite action leading to no results or different results. We will return to the first category in the example given at the end of this chapter. Examples of the second category are the volume and contrast controls of the Apple Emate. To a first time user these appear to be toggling push buttons with an increase and a decrease side. It turns out though that they are not push buttons but sliders. However, today there may be a third variety of products which afford very little: these products do not invite any action. Devoid from meaning they only cause puzzlement. Many videorecorders belong in this category. Groups of controls, identical in size, colour, form, texture and material, are used for a wide variety of different functions. While the controls in themselves may have certain degree of affordance, as a group they do not invite any action, because each control affords the same: the controls do not distinguish themselves in terms of affordance. Thus each control may have a clear 'pushability' affordance, yet this does not help the user to make a decision. Since the user cannot differentiate between the controls on the basis of their formgiving or positioning, he is forced to read the labelling (Figure 7). Note that while generally an affordance conscious designer

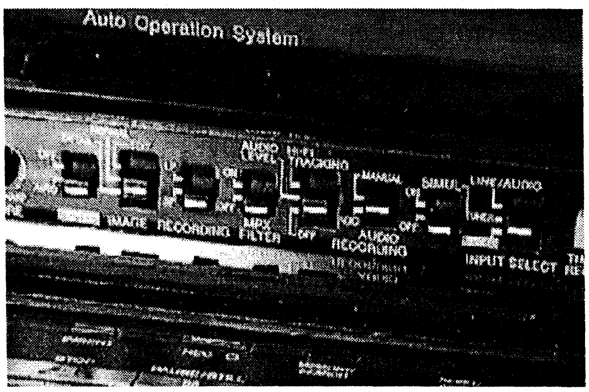


Figure 7: Many of the controls of this videorecorder (Blaupunkt RTV-910 Hi-Fi) are identical in size, form, colour, material and texture. It is impossible to tell them apart without reading their labelling. Since each control affords exactly the same (slidability), in a group the controls afford very little.

will intentionally build-in affordances leading to desired behaviour and avoid affordances leading to non-desired behaviour, there may be some exceptions. For example, intentionally creating misleading affordances is everyday practice for designers of games and trick items.

Affordances vs. Product Semantics

In the list of points of established 'good practice' we included product semantics. While affordances form an elegant framework for inclusion of the other points in the list, the relationship between product semantics and affordances is more complex. Is product semantics really a subset of affordances or vice versa, do they partly overlap and partly differ, or are they one and the same thing? As may be clear from their respective explanations product semantics and affordances stem from very different backgrounds. Product semantics draws upon linguistic and communication theories, while affordances has its roots in the ecological perception theory. Despite these different backgrounds, at the concrete level of designing artifacts it is quite difficult to point out the differences between product semantics and affordances.

As was pointed out in the description of product semantics various design methodologies have resulted from it. There are few examples of design methodologies which take affordances as their basis. Smets et al. (1994) describe three design exercises in which students of industrial design engineering have to design a walkman, a dessert packaging and a sculpture to fit a particular piece of music, the taste of a particular dessert and an artificial scent respectively. Matching experiments show that selected designs successfully reflect another sensory modality and can thus express higher order variables. The article mentions that students were discouraged from relying on cultural cliches by bypassing verbal descriptions and to rely exclusively on the experience of the music, taste or scent. This makes it difficult to identify the methods the students used in achieving their designs.

Table of comparison for Product Semantics and Affordances

This table of comparison (Table 3.1) highlights the main differences and overlap between product semantics and affordances.

Table 3.1: Table of comparison product semantics and affordances

Product semantics	Affordances
Behaviour is influenced by language and other learned signs and symbols	Behaviour is immediately influenced by the environment
Designers can draw upon metaphor. The meaning of the product is the total of all its contexts	Designers should not draw upon metaphor or imagery through verbal association. Designers should 'trust' their senses.
The symbolic meanings and values of a product are central	The perception of meaningful actions is central

However, there is some cross-over in this respect. It would be an oversimplification to state that in product semantics meaningful actions are ignored. One of the dimensions in Lannoch and Lannoch (1987) semantic space is the 'possible actions' dimension (Händlungsmöglichkeitsdimension), which exists next to other dimensions such as a value/convention and relation dimension.

Likewise, elements typical of form semantics, such as product values and meanings, are indeed considered by exponents of affordances. As Smets (1995) puts it: "Form semantics have to do with the manner in which those affordances are expressed in form design. All chairs afford seating, but not all of them are thrones".

Affordances, product semantics and electronic products

Both proponents of product semantics (Lannoch and Lannoch, 1983, Scheuer, 1989) and affordances (Smets, 1995) introduce their articles with the problems posed by electronic products and how their particular theory may contribute to solving those problems. It is disappointing that the positive examples which are given, generally do not deal with expressing the purpose of controls of electronic products. The examples which are given are for what Norman calls surface artifacts rather than internal artifacts. With a surface artifact what is perceived is all there is. With an internal artifact part of the information cannot be perceived as it resides inside the artifact, often in a for humans non-readable form. Internal artifacts therefore need interfaces, so that the internal representations are transformed in a for humans accessible format.

Theorists from both camps, designers and users, will no doubt agree on the need to make controls express their purpose. When shown the examples of surface artifacts they are likely to agree that adopting a design philosophy based on products semantics or affordances is of benefit to those products. However, examples of the application of products semantics or affordances to the real problem of interfaces for electronic, internal artifacts are very hard to come by.

Yet the crux of the problem in human-product interaction is expressing the purpose of controls in electronic products, the need to make the *results* of an action perceivable. The overall formgiving of a product may specify the context and give the user an idea of the product's functionality. That product's controls may express perfectly well what kind of action they require and the details of that action. But still the product may fail to express to the user what activating a control leads to.

In accordance with this view, improvement of product usability may be seen as the implementation of expressivity — showing what the results of action will be — over the full hierarchy of user-product interaction. This hierarchy ranges from showing what the product will do, via what the major controls will do, through ever decreasing levels of importance to clarifying the effects the most minor controls will cause.

Product semantics became stuck after the first level: expressing the functionality of the product. Because the theory of affordances focuses on invited action it raises awareness of the expressive shortcomings of the rest of the hierarchy. It is in this raising of awareness that the value of affordances for industrial design lies. It does not provide the designer with a methodology to actually implement expressivity and to make the results of an action perceivable.

A step towards expressivity: making the result of an action perceivable

How hard it is to implement this expressivity which allows a user to foresee the result of his actions depends upon the nature of the controlled variable. If the variable to be controlled is highly concrete, as for example car seat adjustment (Figure 8), the problem may be easily solved by using highly literal

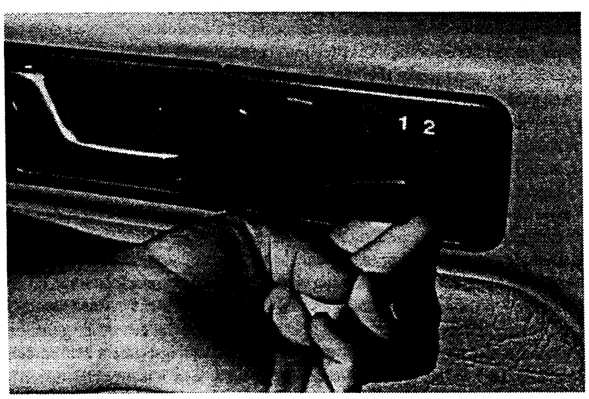


Figure 8: Control for car seat adjustment in a Mercedes

mapping. If the variable is of a highly abstract nature, as for example low quality VHS or high quality S-VHS, it may be much more difficult to express.

It is often said that the workings of electronic based products have become completely abstracted. This is only partly true. A digital camera still has a lens. Electronic video records still work with tape. Even digital video still works with tape. The workings of lenses and tapes are not abstract. There may be developments which will lead to the eventual elimination of lenses and tapes, but for the time being they form essential parts of the most modern equipment.

As the workings of these physical components are not of an abstract nature, variables related to them do have concrete physical manifestations. Only, current product design has a tendency to hide these physical manifestations, even those which are highly informative to a product's operation. A choice is made in favour of an alternative representation of the variable rather than showing its physical manifestation. Consider the following example. There are still many video recorders on the market of which the tape counter does not show absolute elapsed time in minutes and seconds. The tape counter may show elapsed time in meaningless units and the user does not know how many of those units fit to the length of the tape. Or the counter just runs on without considering which tape is in the recorder in which case the counter is also useless without rewinding the tape and zeroing it. The excuse for leaving the user in the dark is that "current tape technology does not allow us to encode time code on the tape". This focus on technology completely foregoes the fact that an approximate answer to the information the user desires, which is, "is there enough tape left to make the recording?" is in fact available. After all, through the window in the tape housing it can be seen how much tape is on one spool and how much on the other. Only, the tape has been hidden inside the recorder thus barring access to this perfectly useful information, and the tape does not express which spool starts as empty. If on the tape or on the tape compartment an approximate guide to elapsed time were shown, the user's question could be answered without having to wait for the latest time coding technology.

Example

Many practical books on interface design teach the desirable in interface design by giving examples of poor design. These negative examples often outnumber the positive examples. we too have given many negative examples in this chapter as positive examples are simply hard to come by. One of the problems with this approach is that it attempts to change the status quo by showing the status quo. Another is that in terms of affordances compromises have been made because of technical or cost issues. What we attempt here is to give an example of how product design could be made more expressive by means of affordances which show what results may be expected from a certain action.

The concept presented here is for a video deck, that is, a video recorder without programming features[1]. We realize that the interface for programming is one of the most difficult parts of a video recorder. The idea behind concentrating on the operation of the tape section is that, if an elegant solution to that part of the problem can be found, there will be less 'noise' surrounding the programming section. Furthermore, the video deck is not complete. There are still many features which have not yet been thought through from an affordances point of view and which remain unimplemented. One such a feature which has been omitted is a remote control. Remote controls are one of today's user interface consumer horrors together with digital watches, digital thermostats and microwave ovens, and there-

[1] The videodeck concept was entered for a competition organized by the Sekisui Design Corporation, Osaka, Japan, in Octobre 1997

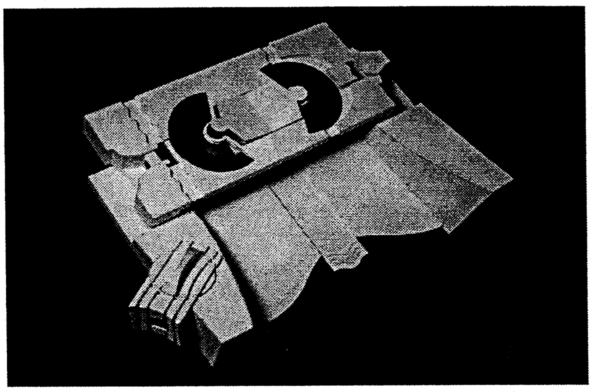
fore do in fact deserve close attention. However, we think that the main problem designers have with remote controls is that they have to create meaningful relationships between one meaningless box - the video recorder - and another - the remote control. We think that the design of an intuitive remote control may prove much easier when the design of the video recorder itself is meaningful.

The video deck as it stands should thus be regarded as a test bed for affordances. While not complete as a product it provides a context for affordances to be meaningful.

Video deck example

Overall formgiving

Figure 9 (left) shows a foam model of the video deck concept. For identification of the device as a



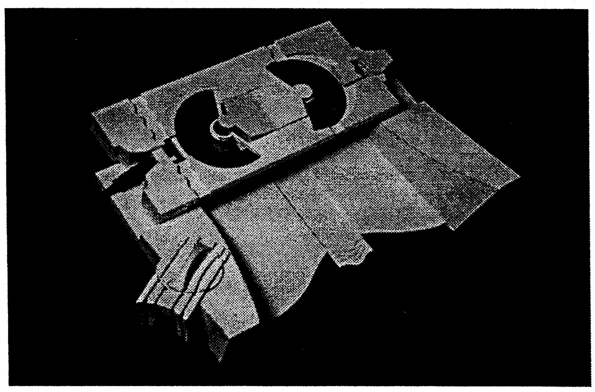


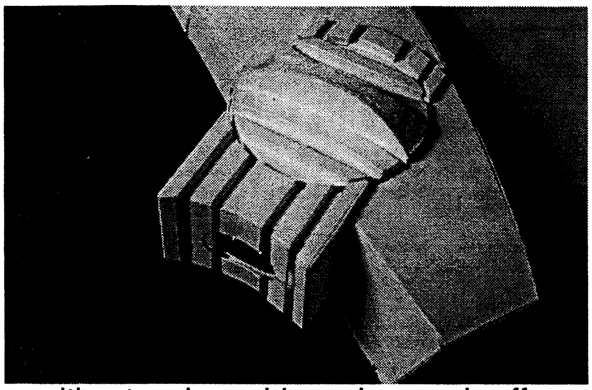
Figure 9: An overview of the video deck without (left) and with (right) cables

piece of video equipment it relies on a tape compartment which shows the tape when present and echoes its form when not. Curving and converging lines indicate the insertion path for the video tape. Figure 9 (right) shows the same model with mains, video-in and video-out cables connected. Note how at each connector the outline of the video deck is broken as an indication that at these locations the device communicates with the outside world.

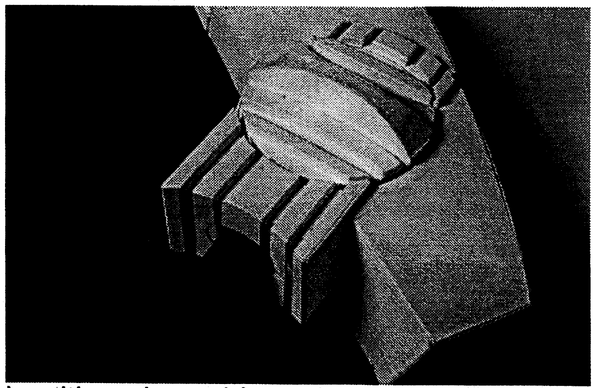
The tape compartment has a degree of direction to it, implying tape movement from the left tape reel to the right, which is indeed the case when the tape is played.

Mains connector and on/off switch.

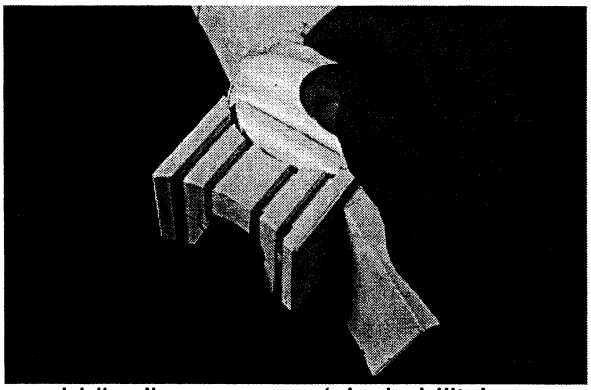
Figure 10 shows the transformer unit with mains connector and on/off switch. The concavity of the surface surrounding the connector hints at the fact that the connector is an input. The ribs are meant to be reminiscent of power. On top of the transformer unit the ribs act as flow lines. The rotary switch diameter is larger than the width of the transformer unit to stress its 'rotatability'. On the rotary switch the ribs are continued. By curving and tapering the ribs and heightening the middle rib on the rotary control 'pinchability' is expressed. The ribs in combination with the rotary control can express blocked flow, i.e. power off, and flow, i.e. power on (Figure 11).



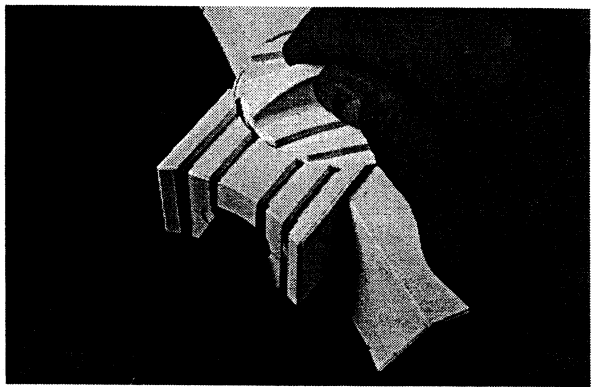
a: without mains cable and power is off



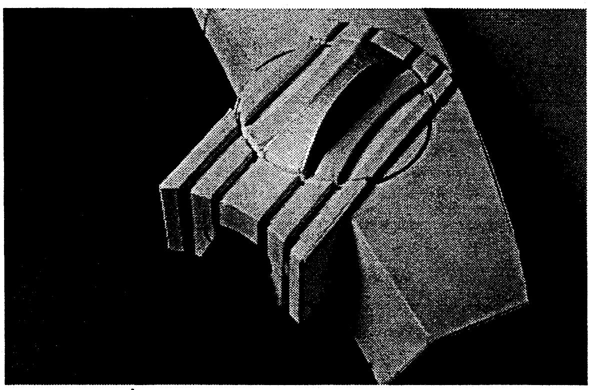
b: with mains cable and power is off



c: middle rib expresses 'pinchability'



d: powering up the video deck



e: power is on

Figure 10: Transformer unit with mains connector and rotary power switch

Fast forward and reverse

The fast forward and reverse control is a toggle (Figure 12), emphasizing its 'either/or' nature. Through the shape of the windows in the tape compartment which reveal the tape the toggle control assumes a two headed arrow like shape.

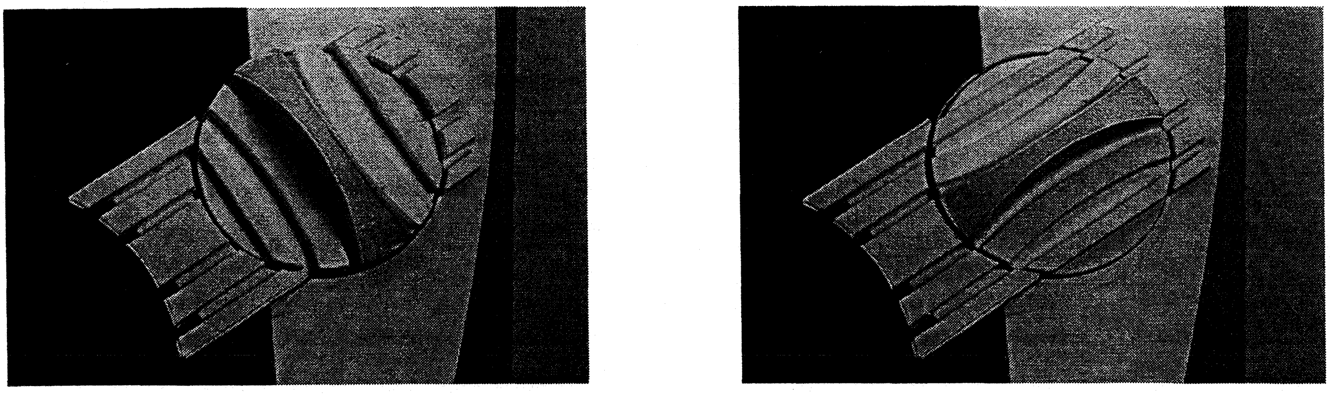
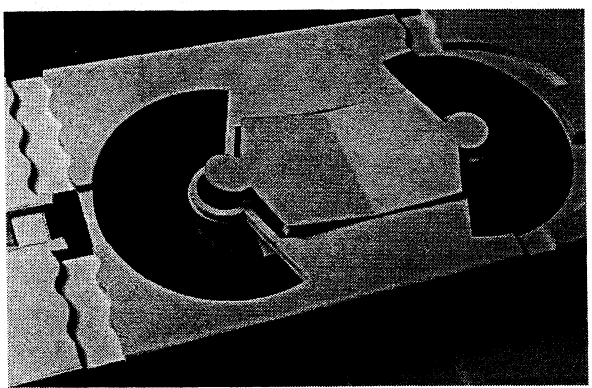
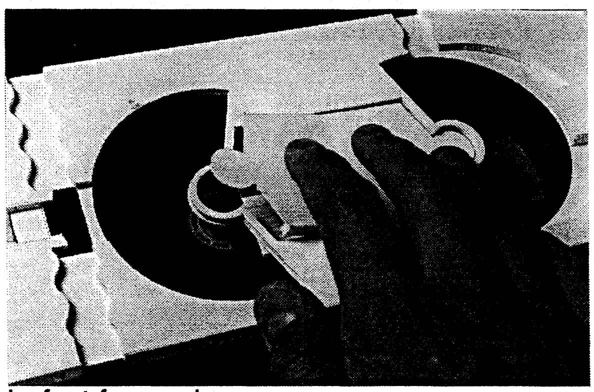


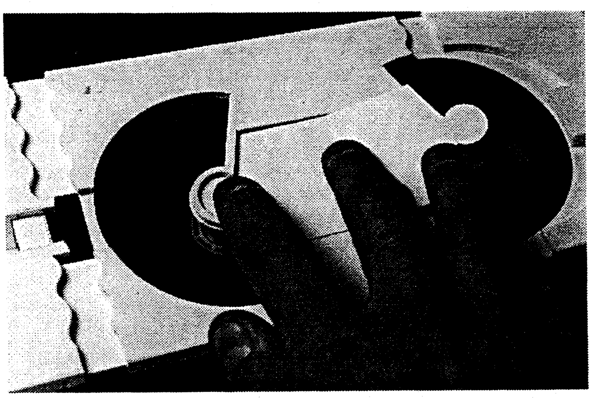
Figure 11: Top view of the power unit switched off (left) and on (right)



a: control is positioned between tape reels



b: fast forward



c: reverse

Figure 12: Fast forward and reverse toggle control

It is positioned in-between the tape reels with the finger sized button parts of the control acting right in the middle of the reels. In combination with the left to right direction of the tape compartment this cues the user that pressing the right part of the toggle will fast forward the tape while the left part will reverse it.

Eject

The eject is a ribbon coming out of the tape compartment (Figure 13). The ribs at the end of the ribbon suggest movement towards the user. Because of its ribbon-like nature only pulling is meaningful, while pushing is not.

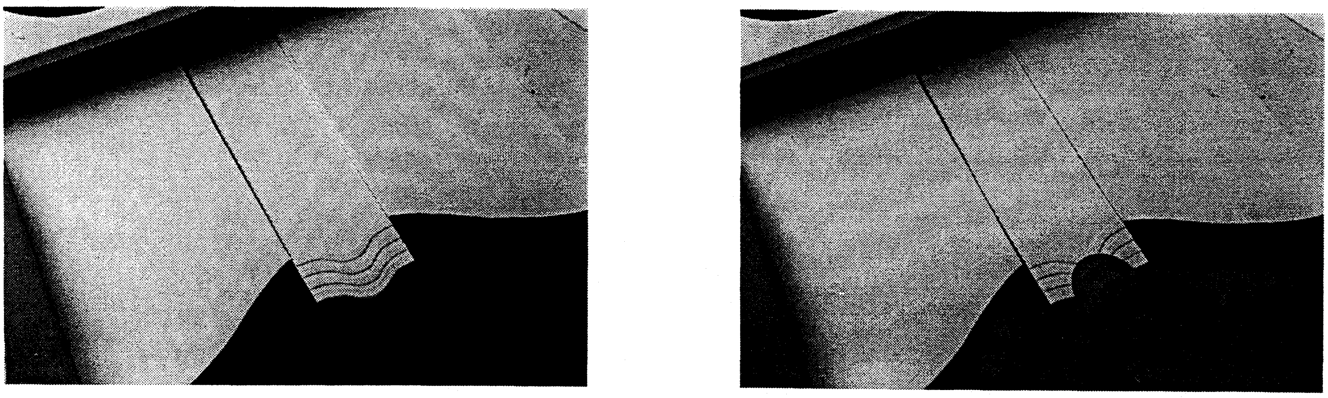


Figure 13: Eject ribbon

Video-out and video-in

With current video recorders it is often impossible to distinguish inputs from outputs except for through their labelling. Here an attempt is made to distinguish video-in and video-out connectors through formgiving. The video-in connector is shown in Figure 14 while the video-out connector is shown in Figure 15. In both cases the connectors are the same but the context in which they are placed is different and says something about their functionality.

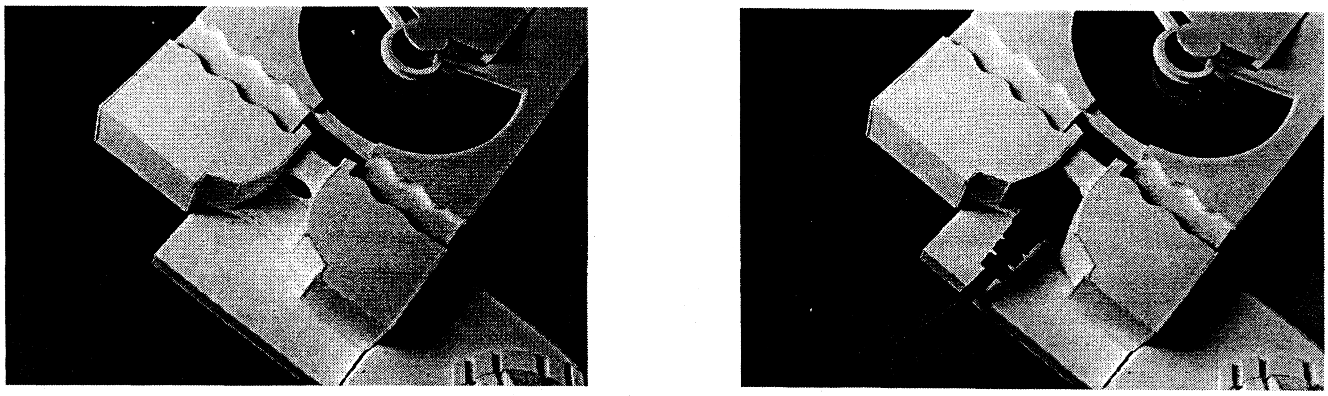


Figure 14: Video-in connector without cable (left) and with cable (right)

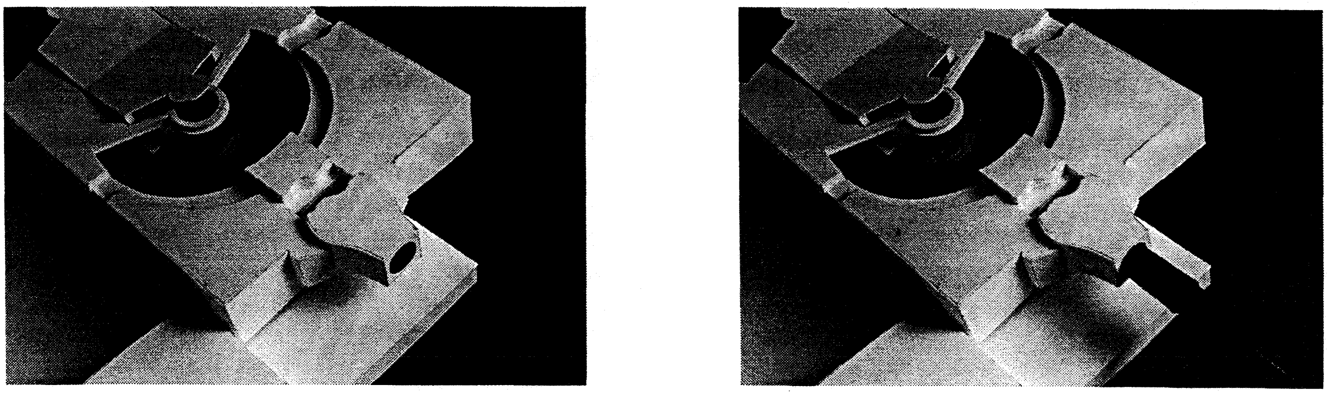


Figure 15: Video-out connector without cable (left) and with cable (right)

Play and record

The play slider is situated to the right of the tape compartment. The wave form indicates that the play slider can mate with the central part of the tape compartment. By pushing the play slider inwards the play function is activated (Figure 16). The play slider houses the video-out socket. This is to emphasize that by sliding the play control inwards and thus activating the play function, information will flow out of the video-out socket to the television.

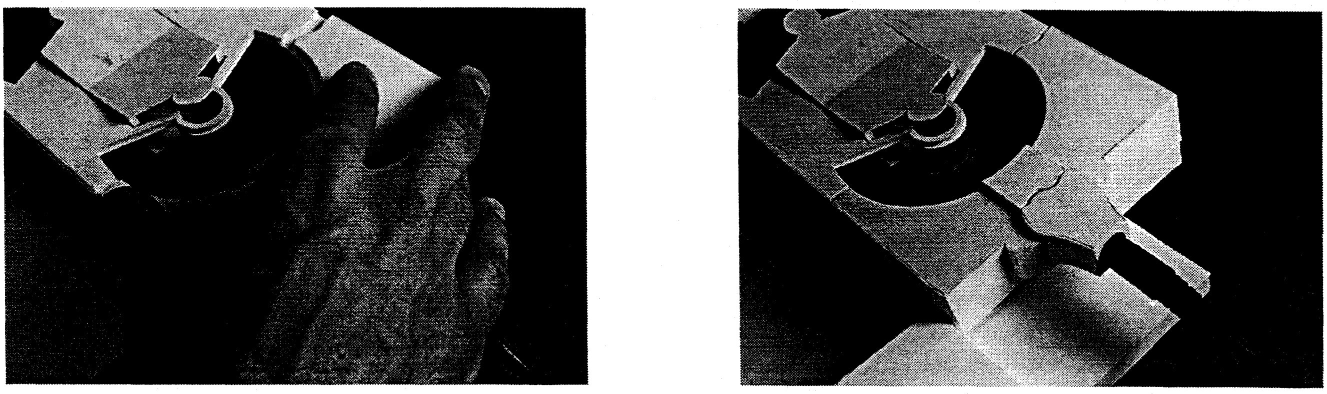


Figure 16: Play slider being activated (left) and the device in play mode (right)

The record slider (Figure 17) is placed to the left of the tape compartment. Again a wave form indicates that the record slider can mate with the central part of the tape compartment. Pushing the record slider inwards activates the record stand-by mode. The record slider houses the video-in socket. In this way we try to stress that by sliding the record control inwards and thus activating record stand-by mode, information flows in through the video-in socket from another video deck.

The play slider envelops half of the right tape reel, something which the record slider does not do with the left tape reel. The forms of the control thus reflect that pushing in the play slider activates tape movement while pushing in the record slider does not. The latter does not cause the tape to run but merely activates record stand-by mode.

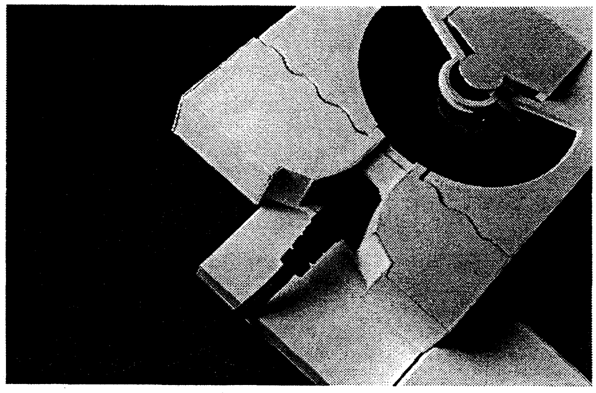



Figure 17: Record slider being activated (left) and the device in record stand-by mode (right)

Note that both these controls violate some of the aspects of 'good practice' mentioned earlier. They do not express well their slidability and how they should be held by the user. The expression of slidability could be improved by adding a ribbed texture on the surfaces which are hidden and revealed by the sliders. To express better that they are controls the forms could be made less edgy and more organic, indicating where the user should place his fingers. On the positive side the forms of these sliding controls do express that they mate with the central part of the tape compartment and their relationships to video-in and video-out.

The different functions (stop, play, record stand-by and record) and how they are activated are summarized in Figure 18.

General remarks

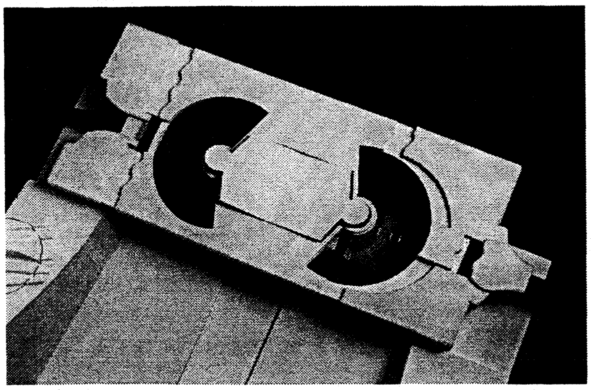
An attempt was made to give all the controls of this video deck human dimensions. Sizes and spacing are generous to allow easy manipulation by human fingers. Note how the controls are both control and display at the same time. There is no need to look at a small electronic display to see whether a tape is present, whether the device is switched on and whether it is stopped, recording or playing. The device and its controls have become displays in themselves.

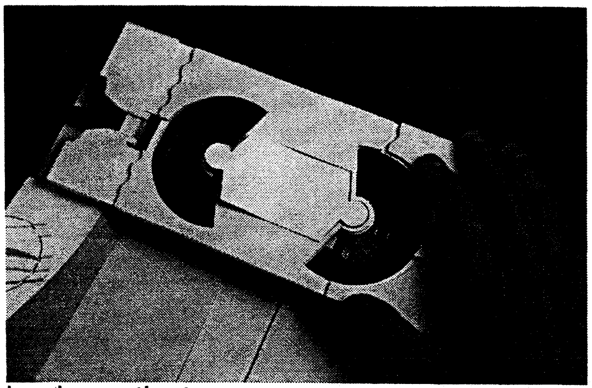
No symbols were printed on the controls. Similarly no colour signs were used for labelling functions. For example, red is often used for labelling the record button. Symbols and 'colour signage by convention' do not fall under affordances as they are not intuitively clear and rely on learning. Yet it may be clear that adding symbols and other agreed signs would eradicate any remaining doubts about the function of a control and would help in preventing the user resorting to a manual.

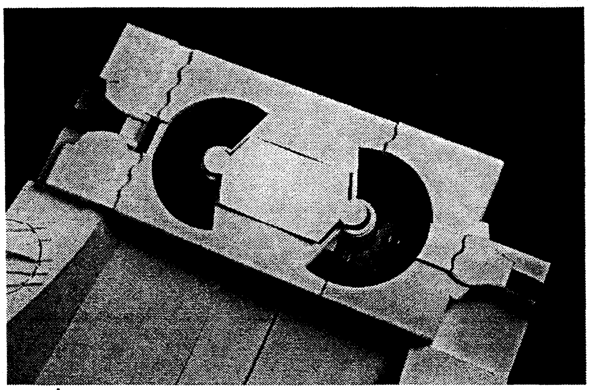
Conclusions

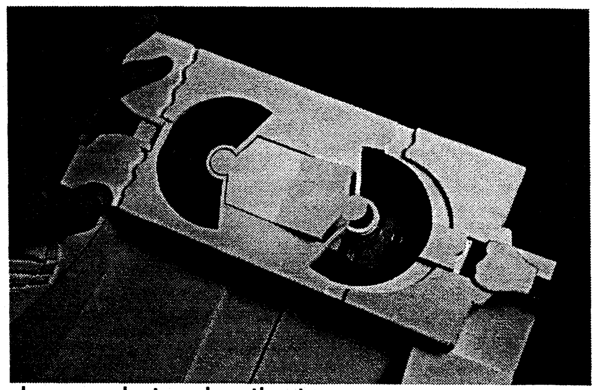
[1] Both product semantics and affordances hold promises to address the expressivity problem in the interface of electronic products. However, as yet examples are limited to products with surface representations rather than electronic ones with internal representations.

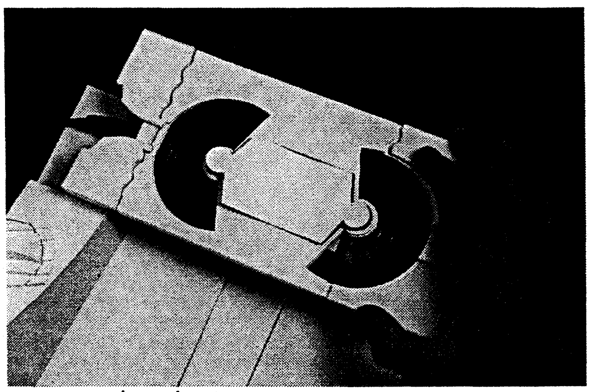
[2] Unlike product semantics, affordances have not yet resulted in practical design methodologies. While a range of 'how to' examples exists for product semantics, such examples as yet do not exist for affordances. For affordances to make an impact in the design world it will be necessary to distil a design methodology from the theory of affordances. As long as this does not happen it will be difficult


a: stop


b: play activate


c: play


d: record stand activate


e: record activate

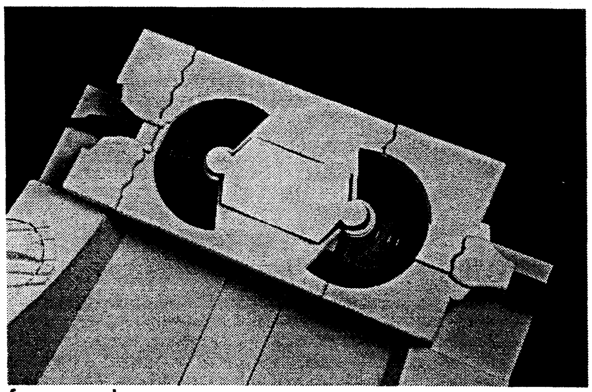

f: record

Figure 18: Summary of the functions stop, play, record stand-by and record

for designers to distinguish between affordances and product semantics, no matter how clear the distinction between the theories from which they originate.

[3] Often decreased usability in modern products is blamed upon the increasing use of electronics in product design. It is true that this trend impairs feedback about a product's internal states. However, the poor usability of products can not be blamed solely on the increased use of electronics. There is a tendency to hide physical manifestations of variables in favour of abstract representations of those

variables. Somehow there is an unshakeable belief in the superiority of these abstract representations on electronic displays. The current trend in design is to create closed, meaningless boxes which prevent the user from interacting with the components hidden inside. When viewed in this light, the struggle of designers to create user-friendly interfaces, can be seen as an attempt to allow the user to communicate through the barrier devised by their own doing.

[4] In books on interface design the negative examples often outweigh the positive ones by a wide margin. We argued that these negative examples need to be complemented with positive conceptual examples. An example of such a conceptual design which focused on usability of the controls of a video deck was given. As it is purely conceptual it does not bear the authority of a positive example which is in production. Yet it is exactly the conceptual nature which could make examples like this valuable. No compromises need to be made for technical, economic or aesthetic reasons. This allows the designer to fully concentrate on usability. By absence of good examples in production, conceptual examples will have to make do. After all, the absence of good examples in production, is not simply the result of technical or economic pressures, or designer laziness. It is the result of a lack of a knowledge in the user-interface community on how usability is influenced by form giving.

Acknowledgements

We gratefully acknowledge C.C.M. Hummels, S. Wensveen, G.J.F. Smets and P.J. Stappers for their constructive criticism.

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This book was set in Stone Serif and Stone Sans by Windfall Software using ZzTEX and was printed and bound in the United States of America.

Library of Congress Cataloging-in-Publication Data

Picard, Rosalind W.
Affective computing / Rosalind W. Picard.
p. cm.
Includes bibliographical references and index.
ISBN 0-262-16170-2 (hc: alk. paper)
1. Human–computer interaction. 2. User interfaces (Computer systems). I. Title.
QA76.9.H85P53 1997
004'.01'9—dc21 97-33285
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Introduction

This book proposes that we give computers the ability to recognize, express, and in some cases, "have" emotions. Is this not absurd? Computers are supposed to be paradigms of logic, rationality, and predictability. These paradigms, to many thinkers, are the very foundations of intelligence, and have been the focus of computer scientists working fervently to build an intelligent machine. After nearly a half century of research, however, computer scientists have not succeeded in constructing a machine that can reason intelligently about difficult problems or that can interact intelligently with people.

Three decades ago, Nobel laureate Herb Simon, writing on the foundations of cognition, emphasized that a general theory of thinking and problem solving must incorporate the influences of emotion (Simon, 1967). Emotion theorists have also argued for the role of emotion as a powerful motivator, influencing perception, cognition, coping, and creativity in important ways. Other results have emerged from neuroscience, cognitive science, and psychology, indicating a pivotal role for emotion in attention, planning, reasoning, learning, memory, and decision making. Some scientists have argued that the demands of a system with finite resources operating in a complex and unpredictable environment naturally give rise to the need for emotions, to address multiple concerns in a flexible, intelligent, and efficient way. Nonetheless, the consideration of emotions for computing has been largely ignored.

Although scientists bicker about a definition of emotion, they agree that emotion is not logic, and that strong emotions can impair rational decision making. Introductory psychology texts have described emotion as "a disorganized response, largely visceral, resulting from the lack of an effective adjustment."[1] Acting "emotionally" implies acting irrationally, with poor judgment. Emotional responses tend to be inappropriate, and even embarrassing. At first blush, emotions seem like the last thing we would want in an intelligent machine.

However, this negative face of emotion is less than half of the story. Before telling the rest of the story, it is prudent to acknowledge that emotions have a stigma, especially among those who prize rational thinking, such as scientists and engineers. Emotions are regarded as inherently non-scientific. Scientific principles are derived from rational thought, logical arguments, testable hypotheses, and repeatable experiments. There is room *alongside* science for "non-interfering" emotions such as those involved in curiosity, frustration, and the pleasure of discovery. Curiosity drives much of scientific inquiry—and the greatest reward of the scientist is often the pure joy of learning. Fear also contributes to science. One can argue that scientific funding via defense budgets has been prompted by fear, such as the fear of not being able to protect our children from attack by another country, or the fear of losing technical superiority. Despite these influences, emotions are usually regarded as acceptable only when they are on the sidelines. If brought more actively into scientific thinking and decision making, then we assume they are negative—wreaking havoc on reasoning. If emotions play a direct and positive role, then it has been overshadowed by this negative one. The negative bias has repelled many a scientist from careful analysis of the role of emotions.

Why do I propose to bring emotion into computing, into what has been first and foremost a deliberate tool of science? Emotion is probably good for something, but its obvious uses seem to be for entertainment and social or family settings. Isn't emotion merely a kind of luxury, that, if useful for computers, would only be of small consequence? This book claims that the answer is a solid "no." Scientific findings contradict the conclusion that human emotions are a luxury. Rather, the evidence is mounting for an essential role of emotions in basic rational and intelligent behavior. Emotions not only contribute to a richer quality of interaction, but they directly impact a person's ability to interact in an intelligent way. Emotional skills, especially the ability to recognize and express emotions, are essential for natural communication with humans.

What about emotion and computers? Shouldn't emotion be completely avoided when considering properties with which to endow computers? After all, computers control significant parts of our lives—nuclear power plants, phone systems, the stock market, airplane flights, automobile engines, and more. We need computers to be predictable and reliable, with clear rational judgment. Our lives sometimes depend on it. Who wants a computer to be able to "feel angry" at them? To feel contempt for any living thing? In the worst case, the consequences might be life-threatening, as in the film "2001" where the emotional computer HAL kills its crewmates, ostensibly out of fear. These questions skitter across the much deeper subject at hand, and I will devote a chapter to potential ethical concerns and less-than-desirable uses of this technology.

In this book I will lay a foundation and construct a framework for what I call "affective computing," computing that relates to, arises from, or deliberately influences emotions. This is different from presenting a theory of emotions; the latter usually focuses on what human emotions are, how and when they are produced, and what they accomplish. Affective computing includes implementing emotions, and therefore can aid the development and testing of new and old emotion theories. However, affective computing also includes many other things, such as giving a computer the ability to recognize and express emotions, developing its ability to respond intelligently to human emotion, and enabling it to regulate and utilize its emotions. Along the way I will weave in both existing work and my own ideas, to begin to fill in the framework.

To complicate matters, nobody knows the answers to basic questions in emotion theory such as: "what are emotions?" "what causes them?" and "why do we have them?" For a list of twelve open questions in the theory of emotion, see Lazarus (1991). These are all openly debated, and evidence lacks on all sides of the debates. To minimize speculation, my treatment of these topics will be limited to those questions essential to the development of affective computing. I will also make suggestions as to how affective computing can help us get closer to answering these important theoretical questions. On the practical side, I will describe new applications of affective computing to areas such as computer-assisted learning, perceptual information retrieval, creative arts and entertainment, and human health and preventive medicine. Most of these are implementable in the near to distant future, but some are being realized today.

I should state a couple of things that I do not intend "affective computing" to address. The first is the pursuit of computers to perform surgical procedures such as cingulotomies—the making of small wounds in the ridge of a part of the brain's limbic system known as the cingulate gyrus, a controversial operation to aid severely depressed patients. Although the use of computers in "tele-surgery" and other medical advances is a significant area of research, such uses are not the focus here. Nor do I plan to discuss how people feel about their computers, and how and why their feelings evolve as they do, even though these are important topics.[2]

On the other hand, I will address how *computers* will be able to recognize, express, and "have" some of these "feelings." The reason for the quotes on "have" and "feelings" will be clarified later, when I carefully describe these concepts. Affective computing is an area of research in need of diligent and sensitive exploration, since machines with affective abilities will need to be skillful and prudent in their use of such abilities. The potential contributions of this research are significant both theoretically and practically—for progress in understanding emotion and cognition, for improvements in how computers reason about and solve problems, for advances in how we may communicate with them, and for how they will influence our own human development.

Songs vs. Laws

Let me write the songs of a nation; I don't care who writes its laws.
—Andrew Fletcher

Emotion pulls the levers of our lives, whether it is love that leads to an act of forgiveness, or curiosity that drives scientific inquiry. As humans, our behavior is greatly influenced by the so-called "song in our heart." Parents, rehabilitation counselors, pastors, and politicians know that it is not laws that exert the greatest influence on people—there are laws prohibiting murder, but there are still murders. Instead, to change the way people behave, one cannot merely change the laws; people's hearts must change. The death penalty has not lowered the murder rate in states where it has been instituted as law; however, murder rates are significantly lower in certain cultures, e.g., in Japan vs. in the United States.

Music, sometimes called "the finest language of emotion," is an apt metaphor, whether it refers to people being influenced by the cultural "tune" or refers to someone with different behavior as "marching to a different drummer." Of course there is no audible tune, and no actual drummer; rather, the metaphor is one of subtle and powerful influence on our behavior—not described simply by laws or rules. To illustrate this influence, imagine the following scenario:

Your colleague keeps you waiting for an important engagement to which you are both strongly committed. You wait with reason, but with increasing puzzlement at her unusual tardiness. You think of promises this delay is causing you to break, except for the promise you made to wait for her. Perhaps you swear off future promises like these.

She is completely unreachable; you ponder what you will say to her about her irresponsibility. But you still wait, because you gave her your word. You wait with growing impatience, frustration, and anger. You waver between wondering "is she ok?" and feeling so irritated that you mutter under your breath, barely joking, "I'll kill her when she gets here."

Finally you give up on your promise to wait. Then she appears. How do you respond?

Whether you greet her with rage or relief, consider the effect of her expression on your response. Suppose she shows up looking carefree and unabashed. You may feel angry and lash out at her. Or suppose she shows up harried, apologetic, with woeful, grieving countenance. You might feel a sudden mixture of relief and forgiveness, and question her compassionately. In other words, the look on her face—her expression of affect—may powerfully influence how you respond. A small communication of emotion can change an entire course of behavior.

In saying that emotions, or "songs," pull the levers of our lives, I am *not* suggesting that laws are unimportant. The legal system has its raison d'etre, despite its notorious abuses and shortcomings. Similarly, systems of laws or rules used by computers have useful applications, despite the acknowledged brittleness of artificial intelligence (AI) rule-based expert systems. Laws are clearly important. However, laws and rules are not sufficient for understanding or predicting human behavior and intelligence.

In fact, evidence indicates that laws and rules do not operate without emotion in two highly cognitive tasks: decision making and perception. Some of the emotional influences for perception have even received special names—such as the fear-induced phenomenon of "tunnel vision," or the joy-induced state of "seeing through rose-colored glasses." But what other evidence is there besides such subjective experiences? Let's consider the role of emotion in perception and decision making, beginning with a somewhat bizarre scenario about perception. Perception is a task that, until recently, was presumed to be primarily cortical, occurring in the highest parts of the brain, together with other high-level rational processes.

Limbic Perception

"Oh, dear," he said, slurping a spoonful, "there are not enough points on the chicken."
—Michael Watson, from *The Man Who Tasted Shapes* (Cytowic, 1993)

Some people feel shapes on their palms as they taste food, like the "points" Michael usually feels when the chicken dish is seasoned correctly. Others see colors as they hear music. These are not drug-induced or voluntary experiences, but rather happen in a natural and involuntary way to people with *synesthesia*, a condition that occurs in an estimated ten people out of every million. A synesthete's brain behaves as if the senses are cross-wired, as if there are no walls between what is seen, felt, touched, smelled, and tasted. The result is heightened perceptual experience. But these crossed perceptions are not explained merely by neurologically "crossed wires."

One would expect that during synesthesia, there would be an increase in cortical activity because of the heightened perceptual experience. The cortex is the physically highest part of the brain, and contains the visual cortex and auditory cortex, the well-studied sites for processing the senses of vision and hearing. The neurologist Richard E. Cytowic studied a variety of aspects of synesthetic experience (Cytowic, 1989), in search of an understanding for how it occurs. He expected to find his explanations in parts of the brain where the senses come together, perhaps in the parietal lobe's tertiary association area where the three senses of vision, touch, and hearing converge. However, to his surprise, Cytowic found that scans of cerebral blood flow[3] during synesthesia episodes indicated a collapse of cortical metabolism. An overall increase of brain metabolism occurred, but it was not in the "higher" cortex, where it was expected.

Instead, Cytowic's studies pointed to a corresponding increase in activity in the limbic system. The limbic system (or more accurately, *systems* since it involves many individual components and functions) is a collection of parts of the brain that lie predominately between the brain stem and the two hemispheres of the cortex (see the "triune brain" in Fig. I.1). Although there is not complete agreement on what parts of the brain constitute the limbic system, it is typically considered to include the hypothalamus, the hippocampus in the temporal lobe, and the amygdala. The limbic system is the seat of emotion, memory, and attention.[4] It helps determine valence (i.e. whether you feel positive or negative toward something) and salience (i.e. what gets your attention). In so doing, the limbic system contributes to the flexibility, unpredictability, and creativity of human behavior. It contains vast interconnections with the neocortex, so that brain functions tend not to be purely limbic or cortical, but a mixture of both.

The degree of limbic activity during synesthesia indicates that the limbic system plays a significant role in perception. In other words, perception is occurring not just in the cortex, but also below the cortex, in the region of the brain that is the primary home of the emotions. Things are not being perceived without going through a system that attaches valence to the memory—positive or negative, like or dislike.

Research on synesthesia is only one of many examples that points to an intervening role for emotions in perception. For example, studies have shown that mood influences perception of ambiguous stimuli. If healthy subjects are asked to quickly jot words they hear, then they are more inclined to spell "presents" than "presence" if they are happy, and to spell "banned" than "band" if they are sad. Subjects resolve lexical ambiguity in homophones in a mood-congruent fashion.[5] Similar results occur when subjects look at ambiguous facial expressions. Depressed subjects judge the faces as having more rejection and sadness.[6] Moods also bias perception of the likelihood of events—an individual in a negative mood perceives negative events as more

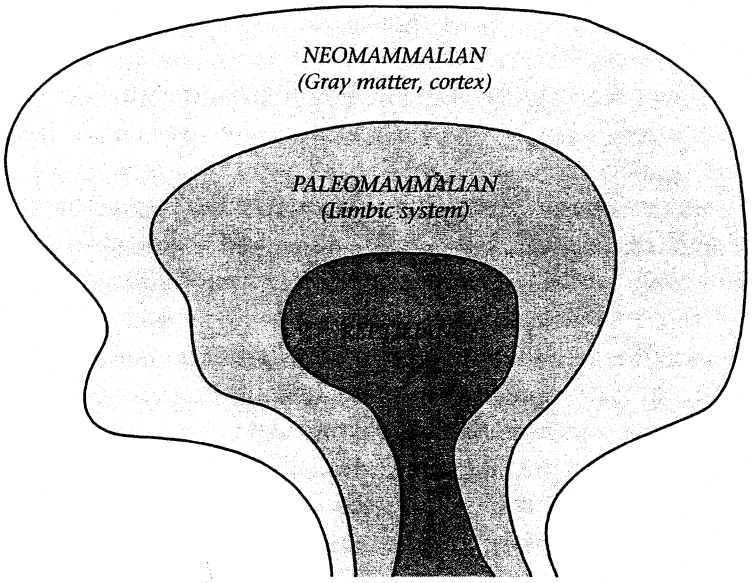

Figure I.1
Paul MacLean's "triune brain" divided the brain into three regions: neocortex, limbic system, and reptilian brain (MacLean, 1970). The neocortex is traditionally the best studied, and contains the visual cortex and auditory cortex; it is where the majority of perceptual processing has been assumed to occur. The limbic system is considered the primary seat of emotion, attention, and memory. Although clear dividing lines are shown here, the functions of the regions are not neatly divided.

likely and positive events as less likely, and the reverse holds true for people in positive moods.[7] In the words of the prominent emotion theorist Carroll Izard, emotion is "both a motivating and a guiding force in perception and attention" (Izard, 1993).[8]

The Limbic-Cortical Tangle

The distinction here between cortical and limbic functions is for emphasis only; in practice, normal limbic and cortical brain areas do not operate in isolation, but are functionally intertwined. The two areas have been artificially separated in how they have been studied, with most emphasis on the cortex. The cortex is easiest to probe as it lies closest to the scalp, and hence has been easiest to study. The limbic system lies below the cortex. Its common adjective of "subcortical" reinforces the old impression that it functions at a level lower than the cortex. However, discoveries such as that of the limbic role in the "high" function of perception imply that a high or dominating function is not necessarily cortical. Even more strongly than the synesthesia findings mentioned above, the research of Joseph LeDoux has shown that other kinds of processing thought to be cortical can be achieved *without* the cortex.

One surprising example of this is that the audio cortex is not always needed for auditory fear conditioning. In particular, if a rat learns that an audible tone is usually accompanied by a shock to its feet, then it will soon exhibit fear when it hears that tone. The rat cannot tell us it is afraid, but it exhibits fear-like behavior, where its blood pressure and heart rate change, it startles easily, and if in a cage, it "freezes" its movement. The surprising result found by LeDoux and his colleagues is that the same behavior occurs even when the audio cortex of the rat is removed. Without an audio cortex, a rat can still learn to fear a tone. But how can hearing happen without an auditory cortex? For decades scientists have assumed that higher perceptual functions such as vision and hearing were cortical.

What LeDoux and colleagues found was that for simple tones, the subcortical structures could recognize the tone, associate it with the likelihood of a shock, and generate the fear response. In particular, they found parts of the thalamus and midbrain that process auditory signals *before* they go to the cortex. Lesions in these regions eliminated the rats' ability to learn to fear the tone. Looking more closely, they found fibers going not only from these regions to the cortex, but also going to the amygdala, a structure central to the limbic system. After extensive careful experiments, they determined that the amygdala is where the learning for fear conditioning occurs initially (LeDoux, 1990). Moreover, this agreed with earlier results found in rabbits and other mammals—and the mechanisms are thought to be similar in all animals that exhibit fear conditioning, including humans (LeDoux, 1994).

Of course, not all perceptual processing occurs in the limbic system. More complex auditory stimuli have been found to require cortical processing. In other words, within its massively parallel system, the brain appears to have at least two paths for perception. The first path—"quick and dirty"—goes straight to the limbic system. When you spontaneously jump out of the way of a suddenly looming large object, then the processing probably occurred by this first path. The second path goes through the cortex and is slower, but more accurate. It allows us to recognize, a moment later, that the big object was an inflatable beach ball, and there was no need to be afraid.

There are substantially more connections from the limbic system to the cortex than vice-versa. These discoveries suggest that not only can the limbic system "hijack" the cortex, such as when it tells you to jump out of the way, but the limbic influence may actually be the greater of the two.[9] This might seem to imply that we are "run by our passions" as might be spoken of someone who does not act reasonably; however, more accurately it implies that even reasonable behavior is neurologically directed by these so-called passions.

Although for decades people have thought that the higher cortical parts of the brain control the lower parts, it is clear now that the lower can also control the higher. Nonetheless, it is commonplace to overlook the role of the lower systems, and especially the pervasive role of emotions and feelings. Cytowic, in remarking on the subtle pervasiveness of emotion's influence, points out that we often hear people say, "Sorry, I wasn't thinking," but we almost never hear "Sorry, I wasn't feeling." Whatever our perception of the role of low-level feelings, the sub-cortical limbic system is a crucial player in our mental activity. It is hard to say conclusively which system of the brain is *directing* the show, but it is clear that the limbic system is a vital part of the performance, even if it is not in the limelight.

Reevaluating Decision Making

Perception is not the only function mistakenly thought of as being purely cortical. Decision making, especially rational decision making, is thought of as a higher cognitive function in the human brain. We all know that "emotional decisions" are generally undesirable—that emotions can derail a rational decision-making process. However, emotions also play a more important role. Let us look at a surprising neurological finding that indicates a critical and paradigm-changing role for emotions.

The Thinking–Feeling Axis

"Scientific conclusions must be decided with the head; whom you choose to marry may be decided with the heart."
—folk advice

"Head" and "heart" are English-language metaphors for thinking and feeling. Most people consider that both head and heart are useful for decision making, as long as they are used suitably for separate purposes, as in the folk advice above. In fact, a tendency is to polarize thoughts and feelings, as if they were opposing phenomena.

The popular Myers-Briggs personality-type indicator provides a good example of this polarization. It characterizes personality via four axes, one of which has the labels "thinking" (T) and "feeling" (F) as opposite endpoints. Most students in technical graduate research programs are biased toward the "T" side. These types of personalities place relatively small emphasis on emotions or feelings relative to thoughts and logical reasoning. Since the developers of computers are largely members of this unusually biased population, it is no surprise to see affect marginalized in models of intelligence constructed by computer scientists.

The Myers-Briggs personality type indicator, when applied to large populations of men and women, reveals a gender bias along only this T-F axis. Two-thirds of men tend to lie closer to the "T" side and two-thirds of women tend to lie closer to the "F" side (Kroeger and Thuesen, 1992). This bias agrees with male-female stereotypes, and is increasingly supported by studies examining what men and women value in communication.[10] It is reasonable to expect that these differences might also extend to how men and women prefer to interact with computers.

Acknowledging the gender bias, affective computers might tend to be considered more feminine for incorporating emotions. However, this conclusion is short-sighted. The human brain, in both males and females, relies on emotion in normal *thinking*. In other words, even the most rational thinking requires participation from the emotion-mediating parts of the brain. Consequently, affective computers should not be considered more feminine, but more human.

The notion of a triune brain simplifies how we look at the systems involved in thinking and feeling, but its simplicity is also a bit dangerous. In particular, it is wrong to deduce from it that there is a clean line between "thinking" and "feeling." Any such line is particularly blurred when we look at decision making. In fact, we find something completely unexpected. First, recall that the brain does not separate cortical and limbic activity. Quoting from the *The Neurological Side of Neuropsychology* (Cytowic, 1996):

> Authorities in neuroanatomy have confirmed that the hippocampus is a point where everything converges. All sensory inputs, external and visceral, must pass through the emotional limbic brain before being redistributed to the cortex for analysis, after which they return to the limbic system for a determination of whether the highly-transformed, multi-sensory input is salient or not.

Not only do functions traditionally thought of as cortical pass through the limbic brain, but the experience of emotion also engages parts of the cortex. In particular, the "frontal lobe" part of the cortex, which lies approximately behind the forehead, communicates significantly with the limbic brain. Damage to this area impairs the normal cortical-limbic interaction, effectively leaving a person with too little emotion.

Too Little Emotion Impairs Decision Making

We all know that too much emotion can wreak havoc on reasoning, but now there is evidence that *too little* emotion also can wreak havoc. This evidence requires a shift from the usual notion of how people separate emotions and rationality. I will give a brief explanation below, and refer the reader to the careful arguments and references assembled by Antonio Damasio in his book, *Descartes' Error* (Damasio, 1994), for the justification such a far-reaching paradigm shift demands.

Damasio's patients have frontal-lobe disorders, affecting a key part of the cortex that communicates with the limbic system. Otherwise, the patients appear to have normal intelligence, scoring average or above average on a variety of tests. At first encounter, these patients appear to be like *Star Trek*'s Mr. Spock—unexpressive of emotions and *unusually rational*. Consequently, one might expect them to be highly intelligent, like Spock.

In real life, however, Damasio's patients make disastrous decisions. Suppose they lose a lot of money with an investment. Unlike healthy people who would learn that the investment is a bad one and stop investing in it, they might continue to invest until all their money is gone. Moreover, this pattern of behavior repeats itself with relationships and other social interactions, usually resulting in the loss of jobs, friends, family, colleagues, and more. Such behavior is far from intelligent. These patients with impaired emotional abilities are, ironically, unable to act rationally.

This disorder is exemplified by "Elliot," whose IQ and cognitive abilities are all normal or above average, but who suffered damage to frontal lobe brain tissue as the result of a brain tumor. When confronted with a simple decision such as when to schedule an appointment, Elliot will disappear into an endless rational search of "Well, this time might be good," or "Maybe I will have to be on that side of town so this time would be better," and on and on. Although a certain amount of indecisiveness is normal, in Elliot it is apparently not accompanied by the usual feelings, such as embarrassment, if someone is staring at you for taking so long to make up your mind. Instead, Elliot's tendency is to search an astronomically large space of rational possibilities. Moreover, Elliot seems to be unable to learn the links between dangerous choices and bad feelings, so he repeats bad decisions instead of learning otherwise. Elliot's lack of emotions severely handicaps his ability to function rationally and intelligently.

Damasio has hypothesized that Elliot's brain is missing "somatic markers" that associate positive or negative feelings with certain decisions. These feelings would help limit a mental search by nudging the person away from considering the possibilities with bad associations (Damasio, 1994). These markers are those that healthy people identify as subjective feelings, "gut" feelings, or intuition.

Apparently, a balance is needed—not too much emotion, and not too little emotion. I suggest that computers, with the exception of some science-fiction creations, have erred on the side of having too little emotion. Artificial intelligence systems produced so far are not too unlike Elliot—they have above average knowledge of some area of expertise, usually encoded as huge set of rules, but they are relatively unintelligent at making decisions. They are unable to associate judgments of value and salience with important decisions. These judgments are products of interactions between the limbic system and the cortex. Little has been done to imitate them in computers.

Damasio's findings point to an essential role of emotion in rational thinking. This is not the first time researchers have come to this conclusion. Johnson-Laird and Shafir have written to the cognition community about the inability of logic to determine which of an infinite number of possible conclusions are sensible to draw, given a set of premises (Johnson-Laird and Shafir, 1993). Even the massive parallelism of the human brain cannot fully search the large spaces of possibilities involved in many day-to-day decisions. How do you decide which paths to search? There is not time to consider *every* possible logical constraint and associated path.

By no means should anyone conclude that logic or reason are irrelevant; they are as essential as the laws of a nation. Additionally, the neurological evidence describes an essential role for emotions, the "songs of the nation" that Fletcher implied were so influential. Therefore, these findings indicate that further study of emotion is essential if we are to understand human cognition, perception, and decision making.[11] The implications are significant also for computer science and industry: computers, if they are to be truly effective at decision making, will have to have emotions or emotion-like mechanisms working in concert with their rule-based systems. If not, we can expect them to have problems like those of Elliot and others who suffer from inadequate emotional abilities. "Pure reason" may continue as a Platonic ideal, but in successful cognitive systems, it is a logical howler.

Tests of Thinking and Intelligence

In normal human cognition, thinking and feeling are partners. If we wish to design a device that "thinks" in the sense of mimicking a human brain, then must it also "feel?"

Consider briefly the classic test of whether or not a machine can think: the Turing test.[12] This test examines whether, in a typical conversation between two participants who have no sensory contact with each other, a human tester cannot tell if the replies are being generated by a human or a machine. There have been competitions to see if a machine could pass this test and, in limited domains, some machines have passed. However, some intelligent people have *not* passed. The test cannot *prove* that a machine (or person) does or does not think; nonetheless, it is a terrific exercise in thinking about thinking.

A test of true thinking must involve emotion. Consider that one might converse with the computer passionately about a song or a poem, or describe to it the most tragic of accidents. To pass the test, computer responses should be indistinguishable from human responses. If a human is put into a highly emotional situation, then he or she will tend to respond with emotion. This observation is an old one, even recognized by Aristotle when he wrote about audiences in his *Rhetoric* :

> Indeed they are always in sympathy with an emotional speaker even when there is nothing in what he says; and that is why many an orator tries to stun the audience with sound and fury.

A Turing test of an affective computer needs to include stunning it with sound and fury, so to speak. To fool the test-giver, the computer would need to be capable of recognizing emotion and synthesizing a suitable affective response.

Although the Turing test is usually performed with text communication, so that sensory expression such as voice intonation and facial expression does not play a role, this does not mean that emotions are not communicated. The power of influencing emotion through language was a primary tenet of Aristotle's *Rhetoric*. In fact, most users of text email find that recipients infer emotion from the email, regardless of whether they intended to communicate emotion through the mail. A machine, even limited to text communication, will communicate more effectively with humans if it can perceive and express emotions.

The crux of testing a computer's intelligence is in determining what questions should be asked of the computer. Hofstadter has suggested that "humor, especially emotion," would comprise the acid test of intelligence for a "thinking machine" (Hofstadter, 1981). The media have exploited this idea in movies where, for example, a human is finally convinced of a robot's intelligence when the robot understands a joke.

Debates still rage, however, about what constitutes thinking, and especially intelligence. As Howard Gardner establishes in his landmark book *Frames of Mind*, human intelligence consists of multiple forms, including social intelligence, which consists of interpersonal and intrapersonal skills (Gardner, 1983). Peter Salovey and John Mayer identify these latter skills as *emotional intelligence*, which they define as "the ability to monitor one's own and others' feelings and emotions, to discriminate among them and to use this information to guide one's thinking and actions" (Salovey and Mayer, 1990). The importance of these skills has been underscored by Dan Goleman in his book, *Emotional Intelligence* (Goleman, 1995), which argues that emotional abilities are more important than traditional IQ for predicting success in life.

Emotional intelligence involves factors such as self-motivation, empathy, self-awareness, impulse control, persistence, and social deftness. Empathy, in particular, requires an ability to recognize and express emotions and, in humans, the ability to experience another's emotions as one's own. Such abilities are tricky to test, and no widely accepted tests exist yet. Nevertheless, emotional skills have profound consequences for how humans perform and interact. I will discuss what these affective abilities would mean for computers in Chapter 2.

Affective Communication

Today it is easy to find people who spend more time interacting with a computer than with other humans. Every day people enter the online communities of the Internet where they communicate with each other *through* computers. Daily interaction between humans and computers has billions of dollars of economic impact, not to mention psychological impact, which is harder to quantify. I will not take space here to review the field of human-computer interaction, which is covered in numerous books and conferences; however, I would like to describe one set of intriguing studies, to motivate another reason for creating affective computers.

This particular set of studies was conducted by Clifford Nass, Byron Reeves, and their colleagues at Stanford University, and is described more fully in their book, *The Media Equation* (Reeves and Nass, 1996). They performed a number of classical tests of human social interaction, substituting computers into a role usually occupied by humans. Hence, a test that traditionally studies a human-human interaction was used to study a human-computer interaction.

For example, one experiment examined how what is said by human A about human B's performance changes when A gives the evaluation face-to-face with B, versus when A gives the evaluation about B to another presumably neutral person. Studies of human social interaction indicate that, in general, humans are nicer face-to-face. In a variation on the traditional test, human B is replaced with computer B. Human A now has to evaluate the computer's performance, say, after the computer gives him a short lesson. Human A gives B its evaluation "face-to-face," and then is asked by a different computer for an evaluation of how B did. The classic human-human results still hold, for example the tendency to be nicer face-to-face remains.

Numerous similar experiments were done by Reeves and Nass, revealing that the classic results of human-human studies are maintained in human-computer studies. The findings hold true even for people who "know better," such as computer science students who know that computers don't have emotions. After accounting for potential biasing factors, the researchers concluded that individuals' interactions with computers are inherently natural and social.[13] Affect is a natural and social part of human communication; therefore, people naturally use it when they interact with computers.[14]

It is not unusual for intelligent people to attribute emotion to things that clearly do not have emotion. For example, someone might wind up a toy dog to make it wag its tail, and say, "How cute—it likes us." Although people *know* that wind-up toys and computers do not have emotions, their default model for relating to others apparently assumes them, most likely because humans are strongly biased for human-human interaction.

Emotion plays an essential role in communication, even in its subtlest form where it merely indicates that communication has succeeded—that we are understood. If you reprimand someone and their facial expression does not change, then the inclination is to continue your communication until you receive a visible or verbal sign that your communication has succeeded. For example, when a look of pain or sorrow appears on their face, then you know you have been understood, and you can cease your reprimand. Body language is also read for signs that communication has succeeded. People watch each other's body language for a response signal to indicate that their message has been interpreted, often repeating their message until the response signal occurs. This tendency to repeat sending the same message may be at the root of the practice of many computer users to repeatedly type the same wrong thing at the computer, or to repeatedly click on something that does not work, as if the computer would notice their increasing frustration and acknowledge it in some way.

Affect recognition and expression are necessary for communication of understanding, one of the greatest psychological needs of people.[15] Suppose someone is terribly upset at you, and you gleefully respond "I understand!" They are not likely to feel understood at all. In contrast, a reflection of their emotion, a sign of empathy, is a sign of understanding. Nicholas Negroponte, in *Being Digital*, reminds us that even a puppy can tell when you are angry with it (Negroponte, 1995). How do we know it can tell? Because it signals this understanding to you. It does not keep wagging its tail during a rebuke, but may put its ears back, its tail down, and drop its head. These are signs that communication has succeeded, that in some simple form, the puppy understands your feelings.

Basic affect recognition and expression are expected by humans in communication. However, unlike the puppy, computers today cannot even tell if you are pleased or displeased. They will scroll screenfulls of information past you regardless of whether you are sitting forward eagerly in your seat, or have begun to emit loud snoring sounds. Computer-based communication is affect-blind, affect-deaf, and generally speaking, affect-impaired. A quantum leap in communication will occur when computers become able to at least recognize and express affect.

Example: The Effective and Affective Tutor

Before moving to the key issues and challenges in affective computing, let's consider an example of its use. One of the research interests at the MIT Media Lab is the building of better piano-teaching computer systems; in particular, systems that can grade some aspects of a student's expressive timing, dynamics, phrasing, etc. This goal contains many challenges, one of the hardest of which involves expression recognition, distilling the essential pitches of the music from its expression. Recognizing and interpreting affect in musical expression is important, and I will return to it later. But first, consider another influence of expression, in a scenario where you are receiving piano lessons from a personal computer tutor:

> Imagine you are seated with your computer tutor, and suppose that it not only reads your gestural input, musical timing and phrasing, but that it can also read your emotional state. In other words, it not only interprets your musical expression, but also your facial expression and perhaps other physical changes corresponding to your emotional feelings—maybe heart rate, breathing, blood-pressure, muscular tightness, and posture. Assume it could have the ability to distinguish the three emotions we all appear to have at birth—distress, interest, and pleasure.[16] Given affect recognition, the computer tutor might gauge if it is maintaining your interest during the lesson, before you quit out of frustration and it is too late for it to try something different. "Am I holding your interest?" it would consider. In the affirmative, it might nudge you with more challenging exercises. If, however, it detects you are frustrated and making lots of errors, then it might slow things down and proffer encouraging feedback. Detecting user distress, without the user making mechanical playing errors, might signal to the computer the performance of a moving requiem, or the presence of a sticky piano key, or the need to ask the user afterward for more information.

The computer tutor should not always just try to make the user happy. Nor should it simply make the lesson easier if the user is upset. Instead, there are intelligent responses that, if given information about what the user is experiencing, can improve the pupil's learning experience. Having access to the user's affective expression is a critical aspect of formulating an intelligent response.

The principles in the piano tutor scenario hold also for non-musical learning tasks—learning a software package, a new game, a foreign language, and more. The topic can vary, but the problem is the same: how should the computer adapt the pace and presentation to the user? How can it know when to provide encouraging feedback or to offer assistance? Certainly, the user should have the option to ask for this at any time; however, it has also been demonstrated that systems that proactively offer suggestions can provide a better learning experience.[17] The tutor probably should not interrupt a user who is doing well, but it might offer help to one who has been getting increasingly frustrated. Human teachers know that a student's affective response provides important cues for discerning how to help the student.

Book Overview

This book is written in two parts: Part I provides the intellectual framework for affective computing and is written to be accessible to all readers. Part II is written for those who are interested in the design and construction of affective computers—fellow researchers, scientists, and engineers—and provides descriptions of tools and progress in this area. Even in Part II, however, I have tried to keep explanations at a level that can be understood by a broad audience.

Part I provides background, motivation, main ideas, applications, and a discussion of potential concerns that arise with affective computing. Chapter 1 overviews relevant concepts from emotion theory, since most readers will not be specialists in that area. Chapter 2 takes what is known about human emotions, and constructs requirements for computers that would have the ability to recognize, express, and "have" emotions. It also discusses emotional intelligence, which will likely have to accompany the other affective abilities if affective computing is to become successful. Chapter 3 describes potential applications of affective computing, including both some that are practical now, and some that are in the indeterminate future, but which allow us to think differently about how computers and our relationships with them might advance. Affective computers, especially those that "have" emotion, raise moral and ethical dilemmas, as well as a number of social and philosophical questions, which are broached in Chapter 4.

Part II provides more depth for those who wish to help realize the ideas and applications in Chapters 2 and 3. Low-level representations of emotions, moods, and human physiological signals are addressed in Chapter 5. Chapter 6 poses human affect recognition as a pattern recognition and learning problem, proposes some models for its solution, and highlights results in affect recognition and expression. Chapter 7 describes models for synthesizing emotions and their influences in computers, particularly in software agents. Finally, Chapter 8 describes the development of affective wearable computers, devices that not only have many exciting future applications, but that also can potentially help advance fundamental understanding of human emotions.

january + february 1999 volume VI.1

interactions

NEW VISIONS OF HUMAN-COMPUTER INTERACTION

design

Cultural Probes

Bill Gaver, Tony Dunne and Elena Pacenti

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Cultural Probes

Homo ludens *impinges on his environment: He interrupts, changes, intensifies; he follows paths and in passing, leaves traces of his presence everywhere.* — Constant

As the local site coordinator finished his introduction to the meeting, our worries were increasing. The group had taken on a glazed look, showing polite interest, but no real enthusiasm. How would they react when we presented them with our packages? Would disinterest deepen to boredom, or even hostility?

Of course an explanation had been necessary for this special meeting with us, three foreign designers. The coordinator explained that we were there as part of a European Union–funded research project looking at novel interaction techniques to increase the presence of the elderly in their local communities. We represented two design centers that would be working over the next two years with three community sites: in the Majorstua, a district of Oslo; the Bijlmer, a large planned community near Amsterdam; and Peccioli, a small village outside Pisa. We were at the last site, to get to know the group a little.

An important preamble, then, well delivered by the coordinator, but the explanation was of necessity fairly complicated. On our arrival, the 10 elderly members had been friendly and enthusiastic, if a little puzzled. Now they were looking tired.

Figure 1. A cultural probe package.

Finally the time came. I stood up and said, "We've brought you a kind of gift," as we all passed the clear blue plastic envelopes to the group. (See Fig. 1) "They're a way for us to get to know you better, and for you to get to know us." Already people were starting to unwind the strings fastening the envelopes. "Take a look," I said, "and we'll explain what's in them."

An assortment of maps, postcards, cameras, and booklets began accumulating in front of them. Curious, they started examining the materials. Soon they were smiling and discussing them with their neighbors.

As the feeling of the group livened perceptibly, we started explaining the contents. Worry transformed to excitement. Perhaps the probes would work after all.

Cultural Probes

The cultural probes—these packages of maps, postcards, and other materials—were designed to provoke inspirational responses from elderly people in diverse communities. Like astronomic or surgical probes, we left them behind when we had gone and waited for them to return fragmentary data over time.

The probes were part of a strategy of pursuing experimental design in a responsive way. They address a common dilemma in developing projects for unfamiliar groups. Understanding the local cultures was necessary so that our designs wouldn't seem irrelevant or arrogant, but we didn't want the groups to constrain our designs unduly by focusing on needs or desires they already understood. We wanted to lead a discussion with the groups toward unexpected ideas, but we didn't want to dominate it.

Postcards

Within the probe packages, people found 8 to 10 postcards scattered among other materials. The cards had images on the front, and questions on the back, such as:

- Please tell us a piece of advice or insight that has been important to you.
- What do you dislike about Peccioli?
- What place does art have in your life?
- Tell us about your favorite device.

The questions concerned the elders' attitudes towards their lives, cultural environments, and technology. But we used oblique wording and evocative images to open a space of possibilities, allowing the elders as much room to respond as possible.

Postcards are an attractive medium for asking these sorts of questions because of their connotations as an informal, friendly mode of communication. (See Fig. 2) Unlike formal questionnaires, the postcards encouraged questions to be approached casually, which was underlined by pre-addressing and stamping them for separate return.

Maps

The probes contained about seven maps, each with an accompanying inquiry exploring the elders' attitudes toward their environment. (See Fig. 3)

Requests ranged from straightforward to poetic. For instance, a map of the world included the question "Where have you been in the world?", and small dot stickers were provided to mark answers. Participants were also asked to mark zones on local maps, showing us where, for instance,

- ✘ They would go to meet people
- ✘ They would go to be alone
- ✘ They liked to daydream
- ✘ They would like to go but can't

A more surreal task was given to each group as well; in the case of Peccioli, for example, a map was labeled "if Peccioli were New York..." and was accompanied by stickers showing scenes ranging from the Statue of Liberty to people injecting drugs.

The maps were printed on a variety of textured papers to emphasize their individuality and cut into several different envelope forms. When the elderly were finished with them, they folded them together and put them in the mail.

Camera

Each probe included a disposable camera, repackaged to separate it from its commercial origins and to integrate it with the other probe materials. On the back we listed requests for pictures, such as

- ✱ Your home
- ✱ What you will wear today
- ✱ The first person you see today
- ✱ Something desirable
- ✱ Something boring

About half the pictures were unassigned, and the elders were asked to photograph whatever they wanted to show us before mailing the camera back to us. (See Fig. 4)

Photo Album and Media Diary

The last two items in the probes were in the form of small booklets. The first was a photo album, which requesting the elders to "use 6 to 10 pictures to tell us your story." When questioned, we encouraged participants to use photos of the past, their families, their current lives, or anything they found meaningful. (See Fig. 5)

Finally, each probe contained a media

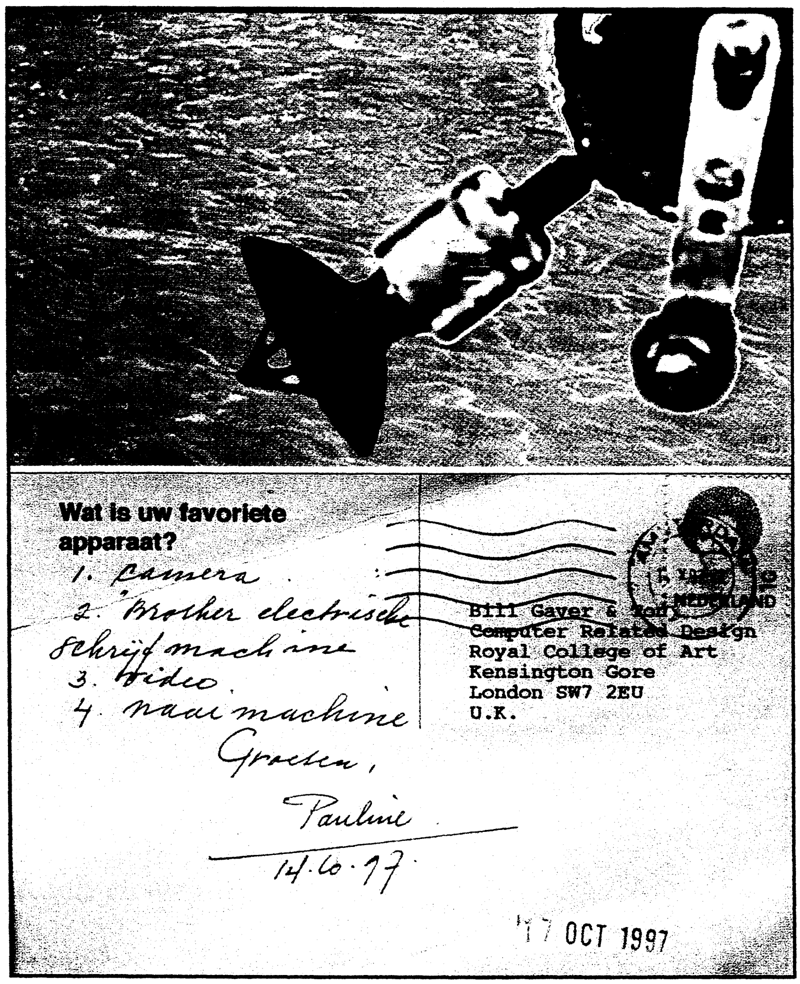

Figure 2. A postcard ("what is your favorite device?")

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diary, in which elderly participants were asked to record their television and radio use, including what they watched, with whom, and when. They were also asked to note incoming and outgoing calls, including their relationship with the caller and the subject of the calls. The entries were made daily, for a total of a week.

Context

A number of converging interests and constraints were involved in designing the probes. The Presence Project has been funded for two years under the European Union's 13 initiative. Eight partners from four countries are exploring technologies to increase the presence of the elderly in their local communities. This is a relatively unconstrained project, defined only in terms of its overall goal and its flow over time. The first year has been spent on opening a space of possible designs; the second will focus on developing prototypes to be tested in the sites.

The sites themselves constrain the sorts of design explorations that might be meaningful. In Oslo, we are working with a group of elderly who have been learning to use the Internet at a local library. In the Netherlands, the elders live in the Bijlmer, an extensive planned community with a poor reputation. Finally, the Italian site is in Peccioli, a small Tuscan village where an elder center is being planned. The diversity of the sites was clear from the outset. Our task was to better understand their particularities.

The openness of the design brief, and the availability of more quantitative demographic data from the local sites, meant that we could freely explore many different aspects of the elders' attitudes. Of course, we might have used more traditional methods to do this, including perhaps ethnographic studies, interviews, or questionnaires. That we didn't stems, in part, from how we think about doing research through design.

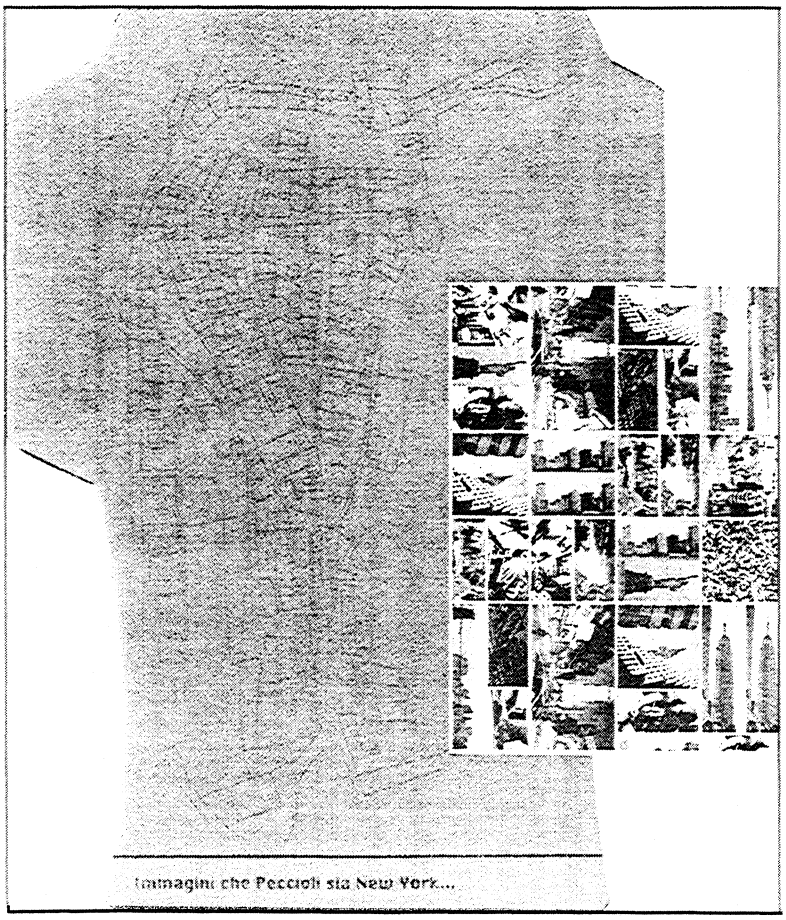

Figure 3. A map ("if Peccioli were New York...")

Design as Research

We approach research into new technologies from the traditions of artist–designers rather than the more typical science- and engineering-based approaches.

Unlike much research, we don't emphasize precise analyses or carefully controlled methodologies; instead, we concentrate on aesthetic control, the cultural implications of our designs, and ways to open new spaces for design. Scientific theories may be one source of inspiration for us, but so are more informal analyses, chance observations, the popular press, and other such "unscientific" sources.

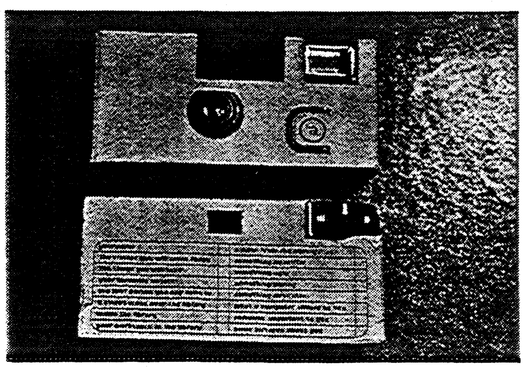

Figure 4. Camera

Unlike most design, we don't focus on commercial products, but on new understandings of technology. This allows us—even requires us—to be speculative in our designs, as trying to extend the boundaries of current technologies demands that we explore functions, experiences, and cultural placements quite outside the norm.

Instead of designing solutions for user needs, then, we work to provide opportunities to discover new pleasures, new forms of sociability, and new cultural forms. We often act as provocateurs through our designs, trying to shift current perceptions of technology functionally, aesthetically, culturally, and even politically.

Inspiration, not Information

The artist–designer approach is openly subjective, only partly guided by any "objective" problem statement. Thus we were after "inspirational data" with the probes, to stimulate our imaginations rather than define a set of problems.

We weren't trying to reach an objective view of the elders' needs through the probes, but instead a more impressionistic account of their beliefs and desires, their aesthetic preferences and cultural concerns. Using official-looking questionnaires or formal meetings seemed likely to cast us in the role of doctors, diagnosing user problems and prescribing technological cures. Conversely, we didn't want to be servants either, letting the elders set the directions for our designs. Trying to establish a role as provocateurs, we shaped the probes as interventions that would affect the elders while eliciting informative responses from them.

Combating Distance

To establish a conversation with the elder groups, we had to overcome several kinds of distance that might separate us, some endemic to most research, some particular to this project. Foremost was the kind of distance of officialdom that comes with being flown in as well-funded experts. Trying to reduce this sort of distance underlay a great deal of the tone and aesthetics of the probe materials.

Geographic and cultural distances were more specific problems for this project. We designed the materials to be posted separately, both to acknowledge our distance and to emphasize our ongoing lives in other countries (thus we used our names in the addresses, as opposed to an institutional title like "The Presence Project"). We also tried to design the materials to be as visual as possible, to some extent bypassing language barriers.

Respecting Our Elders

A particularly important gap for us to bridge was the generational gap implied by designing for another age group. To encourage a provocative dialogue about design, we tried to reject stereotypes of older people as "needy" or "nice." This freed us, in turn, to challenge the elder groups, both through the probes and our eventual designs.

Figure 5. Photo album

Moving beyond a view of older people as needy or nice has allowed us to view them in new ways, opening new opportunities for design. For instance, elders represent a lifetime of experiences and knowledge, often deeply embedded in their local communities. This could be an invaluable resource to the younger members of their community.

Conversely, elders also represent a life free from the need to work, and thus the possibility of exploring life as *homo ludens*, humanity defined by its playful qualities. Our designs could offer them opportunities to appreciate their environments—social, urban, and natural—in new and intriguing ways.

Functional Aesthetics

Throughout the project, we have viewed aesthetic and conceptual pleasure as a right rather than a luxury. We didn't work on the aesthetics of the probes simply to make them appealing or motivating but because we believe aesthetics to be an integral part of functionality, with pleasure a criterion for design equal to efficiency or usability.

We worked to make the probe materials delightful, but not childish or condescending. In fact, the aesthetics were somewhat abstract or alien in order to encourage from respondents a slightly detached attitude to our

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requests. But although the materials were aesthetically crafted, they were not too professionally finished. This gave them a personal and informal feeling, allowing them to escape the genres of official forms or of commercial marketing. In the end, they revealed the energy we put into them and expressed our tastes and interests to the groups.

The aesthetics of the packages were thus another attempt to reduce the distance between us and the groups. Through the materials and images and the requests we made, we tried to reveal ourselves to the groups as we asked them to reveal themselves to us. Not only did this make the probes themselves enjoyable and communicative, but it meant that they started to hint at what the elders might expect from our eventual designs.

Applying Conceptual Art

The conceptual concerns and specific techniques of various arts movements also influenced our design. For instance, our maps are related to the psychogeographical maps of the Situationists [1] (see the sidebar), which capture the emotional ambience of different locations. Unfamiliar with the local sites ourselves, we asked the local groups to map them for us. Not only did this give us material to inform our designs, but, we hope, provoked the elders to consider their environment in a new way.

We used other techniques from groups such as Dada, the Surrealists, and more contemporary artists in the probes as well. They incorporated elements of collage, in which juxtaposed images open new and provocative spaces, and of borrowing and subverting the visual and textual languages of advertisements, postcards, and other elements of commercial culture. Finally, we tried to use, judiciously, tactics of ambiguity, absurdity, and mystery throughout, as a way of provoking new perspectives on everyday life.

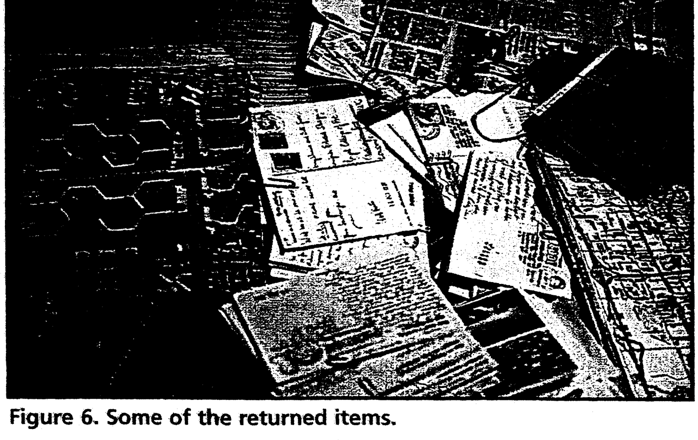


Figure 6. Some of the returned items.

Launching the Probes

We gave the probes to members of the elder groups in a series of meetings at the local sites, like the one described in the beginning of this paper. We did not describe every item, but instead introduced the types of things they would find. We wanted them to be surprised as they returned to the packages over the following weeks.

Originally we had planned to send the packages to the groups, but we were afraid they might reject the unusual approach we were taking. We decided to present them ourselves to explain our intentions, answer questions, and encourage the elders to take an informal, experimental approach to the materials.

This turned out to be an extremely fortunate decision, because one of the unexpected strengths of the probes was in sparking a dialogue between us and the elderly. What we feared would be polite group discussions turned out to be spontaneous and personal, and we learned a great deal about the groups in discussing the materials. Even after we left, some of the elders sent us personal greetings beyond the materials themselves—postcards, letters, even personalized Christmas cards.

The Returns

For about a month after we left each site, we started receiving the completed materials, at a rate that seemed to compare favorably with that for other methods. Every day or so, we would find another few postcards, maps, or cameras in our post, which allowed us to scan and sort them in a piecemeal and leisurely fashion. (See Fig. 6)

Some of the items that the elders returned were left blank or they included notes about why the given request was difficult. We had encouraged this in the meetings, as a way of keeping the process open to the elders' opinions. And in fact, we redesigned the materials for each group as we received returns from the last.

Sorting through the masses of maps, cards, and photographs that we received, strong and differentiated views of the three sites began to emerge. Some items acted as beacons for us—a photograph of friends at an Italian café, a map of the Bijlmer with extensive notes about the "junkies and thieves" in the area, a joke about death from Oslo. They seemed to capture particular facets of the cultures, clearly symbolizing important issues. (See Fig. 7)

The return rates from the groups added to our impressions of their differences. The Oslo group returned almost all the materials, and thus seemed enthusiastic and diligent. The Bijlmer group returned a bit more than half the materials: they seemed less convinced by the project but willing to take part in tasks they found meaningful or provoking. Finally, the Peccioli group returned less than half the materials, despite being enthusiastic when they received them. We take this as a sign that they are well meaning but happily distracted by their daily lives—an important factor for our designs.

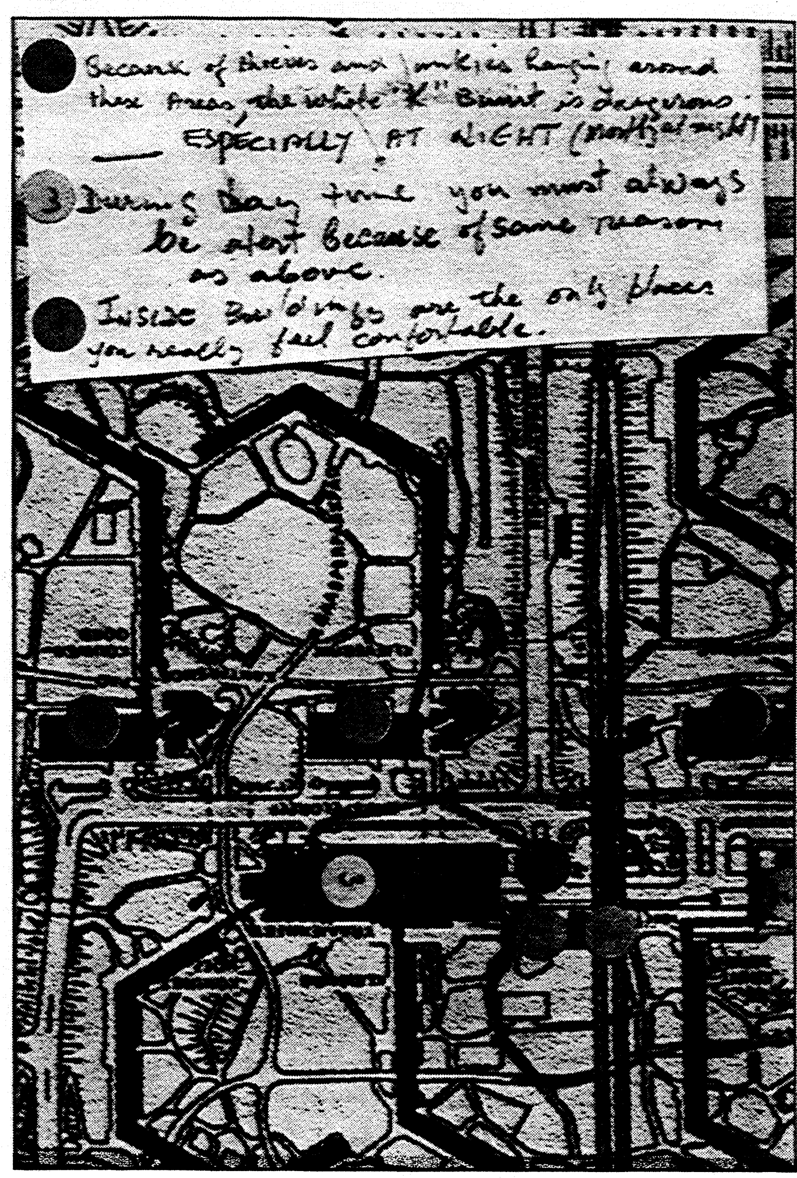


Figure 7. A returned map showing zones of safety and fear in the Bijlmer.

From Probes to Designs

The probes were not designed to be analyzed, nor did we summarize what they revealed about the sites as an explicit stage in the process. Rather, the design proposals we produced reflected what we learned from the materials. For the Royal College of Art, the probe materials allowed the different characters of the three sites to emerge, which we are reflecting in quite different design scenarios:

- ✦ In the Bijlmer, our ideas respond to the paradox of a strong community in a dangerous area: We have proposed building a network of computer displays with which the elderly could help inhabitants communicate their values and attitudes about the culture.
- ✦ The group in Oslo is affluent, well educated, and enthusiastic: We are proposing that they lead a community-wide conversation about social issues, publishing questions from the library that are sent for public response to electronic systems in cafés, trams, or public spaces.
- ✦ Finally, the elders in Peccioli enjoy a relaxed social life in a beautiful setting. We plan to amplify their pleasure by creating social and pastoral radioscapes, allowing them to create flexible communications networks and to listen to the sounds of the surrounding countryside. (See Fig. 8)

For the Domus Academy, the returns suggested a range of nonstereotypical profiles of elders that were less focused on the particular sites. For instance, many elders are experts on

Figure 8. From the proposal for the bijlmer.

the current status and history of their communities and might serve as local information resources, perhaps by guiding tourists. They are eager to keep in touch with friends and families, and thus new technologies might support relationships with distant relatives or with children and grandchildren closer to home, or might provide forms of "soft surveillance" or informal help chains to combat social isolation. Finally, the elderly might provide a living memory of a particular community, enriching the physical environment with virtual traces of its history.

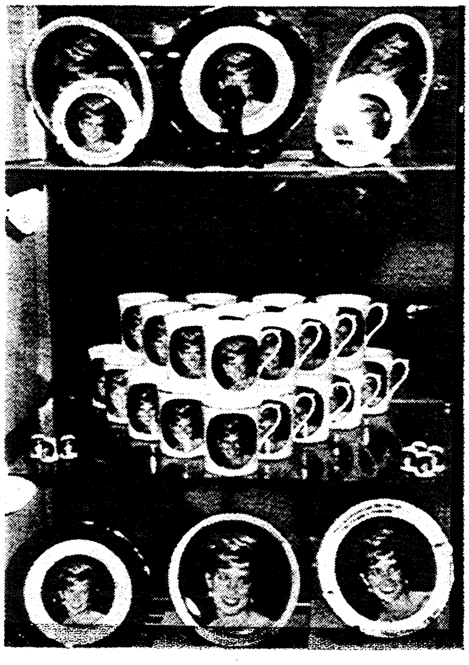
These proposals were our reply to the elders' responses to the probes, integrating what we learned about them with suggestions for new possibilities. The best evidence that the returns from the probes spurred valuable insights into the local cultures was that the elders clearly recognized themselves in the proposals. Although some of our suggestions were intended to be strange or provocative, the elders became readily involved with them, making suggestions for reshaping the ideas, but without breakdowns in the conversation that would have indicated our perceptions

The Situationists

One influence on our work is the Situationists [1, 3], a collective of artist-provocateurs based largely in Paris from the late 1950s to early 1960s.

Like the Dadaists and Surrealists (e.g., [2]), the Situationists wanted their art to be revolutionary, reawakening passion and unconscious desires in the general public. Fundamental in this approach was their analysis of the ways that commercial culture expropriates people's experience into the "Spectacle," an all-encompassing, media-fueled show. As the Spectacle subsumes ideas, desires, even protests, people are forced into an alienated position, as consumers of their own experience.

The Situationists used artistic strategies both as a radical critique of the Spectacle and as concrete research into the promise of new cultural possibilities. Art was to be liberated from the safe enclave of established galleries and used to seduce and confront ordinary people. They mass-produced paintings sold by the yard; altered prints, comic strips, and advertisements; and created new architectures to be changed at will by the people who lived in them. Throughout, they embraced disorientation and confusion as methods for liberation.



Psychogeographical maps were developed to represent the city's topology of desire, fear, isolation and sociality, to challenge the cultural homogeneity assumed by commercial interests. Situationists took *derivés*, meandering around the city guided only by the landscape of impulse and desire, and mapped what they found. We have borrowed from this technique for the cultural probes. More generally, we approach our design in their spirit of functional pleasure.

were crude or mistaken. This notion of a continuing conversation with the elders has been pivotal to our understanding of the probes as a method.

User-Centered Inspiration

Although the probes were central to our understanding of the sites, they didn't directly lead to our designs. They were invaluable in making us aware of the detailed texture of the sites, allowing us to shape proposals to fit them. But we were also influenced by our preexisting conceptual interests, our visits to the sites, anecdotes and data about the areas from the local coordinators, and readings from the popular and specialist press. Just as many influences went into designing the probes, so have they been one of many influences on our design process.

The cultural probes were successful for us in trying to familiarize ourselves with the sites in a way that would be appropriate for our approach as artist–designers. They provided us with a rich and varied set of materials that both inspired our designs and let us ground them in the detailed textures of the local cultures.

What we learned about the elders is only half the story, however. The other half is what the elders learned from the probes. They provoked the groups to think about the roles they play and the pleasures they experience, hinting to them that our designs might suggest new roles and new experiences. In the end, the probes helped establish a conversation with the groups, one that has continued throughout the project.

We believe the cultural probes could be adapted to a wide variety of similar design projects. Just as machine-addressed letters seem more pushy than friendly, however, so might a generic approach to the probes produce materials that seem insincere, like official forms with a veneer of marketing. The real strength of the method was that we had designed and produced the materials specifically for this project, for those people, and for their environments. The probes were our personal communication to the elders, and prompted the elders to communicate personally in return.

"The game should be played for some length of time to arrive at the most curious results. The questions, as well as the answers, are to be considered as symptomatic."

— J. Levy, Surrealism

Acknowledgments

The Presence Project is supported by a grant from the European Union under the I3 initiative. We are extremely grateful to the members of the three groups and to Sidsel Bjorneby, Simon Clatworthy, Danielle van Diemen, and Cecelia Laschi, the local site coordinators. We thank Ben Hooker and Fiona Raby for help with the design and production of the probe materials and Anne Schlottmann for helpful comments on this paper. Finally, we thank our partners from the Domus Academy, Netherlands Design Institute, Telenor, Human Factors Solutions, Scuola Superiore Sant'Anna, and IDEA.

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Feather, Scent, and Shaker: Supporting Simple Intimacy

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ABSTRACT

In this paper, we describe three experiments in designing for minimal, expressive communication. These are very simple networked devices that are aimed at supporting implicit, personal, and expressive communication, as opposed to the explicit, goal-oriented, and informative communication characterising most CSCW systems. We suggest that these prototypes open an interesting space for collaborative systems, and describe some of the issues and opportunities they raise.

INTRODUCTION

Systems supporting collaboration tend to share three characteristics: They rely on relatively explicit communicative acts, they stress the exchange of information, and they support goal-oriented activities.

In everyday life, on the other hand, sociality is often a more subtle and delicate thing. Think of being in the same room with a close friend or lover. There may be no explicit communication, but instead a myriad of more basic visual, auditory, and tactile links are shared. No information may be exchanged, but emotions, even simple contentment, may be expressed. And no goals may be pursued or met, but instead mere togetherness may lead to a feeling of warm companionship.

Could systems be developed to support this sort of intimacy at a distance? In this paper, we describe three prototypical systems designed to support simple, expressive interaction, and then discuss the issues and opportunities that they raise.

FEATHER

The first system, Feather, is designed for situations in which one person is travelling while another stays at home. The aim is to indicate, simply and expressively, when the travelling partner is thinking of the other.

Two devices are used. The traveller carries a small object that signals that his or her attention is focused on the other (see Figure 1). This is envisioned as a kind of picture frame, but one contrived so that it invites activities that can be used to send a signal to the other object. In one version, this involves turning over the object, which otherwise sits picture-side down. In another, the object encourages lifting to view the image. This gives a precious, almost reverential feel to the interaction, and holding the object closes a circuit between the two halves of the unit, sending a signal to the other object.

The second object is larger, meant, like a piece of furniture, to be a relatively stable feature of the home (Figure 1). It contains a small and quiet electric fan in its base, and a single feather that rests on an unobtrusive grill above it. When triggered by the absent partner holding the picture frame, the fan starts, wafting the feather into the air. The drifting feather is constrained by a clear, cone-shaped plastic enclosure extending from the base, and lifts and dips naturally as it catches the wind.

The combination of picture and feather provides an ephemeral, poetic experience of connection. Handling the picture object becomes an act of affection and reflection, made more poignant by the possibility of the other's awareness. Seeing the feather drifting in the air intimates the other's attention with a lightness and dynamic that reflects the transience of thought.

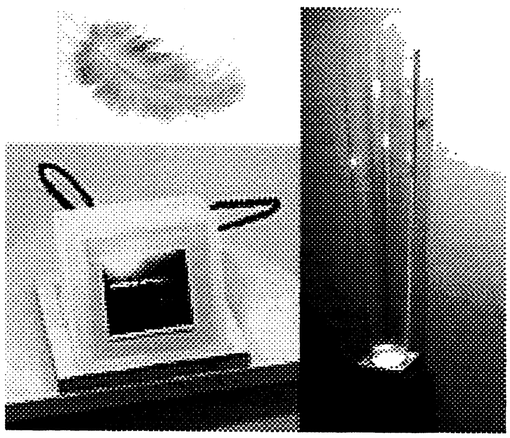

Figure 1: Feather

SCENT

The second system, Scent, is a variation on Feather. Again, a traveller takes the picture object, which invites handling both to see the picture and to signal the viewer's activity. In this system, however, handling the picture object starts a heating element at the bottom of an aluminium bowl, vaporising essential oil deposited within. The result is that a scent fills the home space to indicate the traveller's thoughts, lingering for a time before fading away.

Using scent to express connection allows a persistence that the Feather does not. The feather's movement lasts little longer than the picture is handled, and may be easy to miss even if the home-based partner is present. The scent is more pervasive, lingering like a memory after the initial signal is received. Scent is also supposed to conjure emotions and memories more profoundly than vision, and personally significant scents might be chosen to enhance this effect.

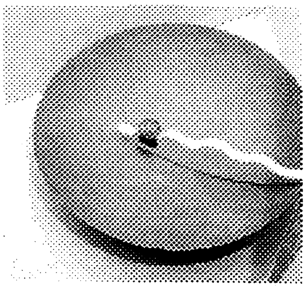

Figure 2: Scent

SHAKER

Shaker is designed for less intimate friendships and more symmetrical communication than are Feather and Scent. The system consists of two pairs of devices, one pair carried by each partner (Figure 3). Each contains a solenoid, consisting of a metal rod surrounded by a wire coil. When the Sender is shaken, the movement of the rod induces a current in the coil. When this (or a digitised version) is sent to the Receiver, the current causes its solenoid to shake the Receiver proportionally.

Shaker permits the exchange of fairly subtle tactile gestures. There is not a one-to-one correspondence between the units' movement, but the timing and amplitude is maintained. Ideally, the sender and receiver would be built into a single unit, with feedback reduced by orthogonal send and receive axes. Shakers could be of a form and size that makes them easy to carry or wear as jewellery, using pager or cellphone technology to link them. In any case, the aim is to encourage entertaining and light-hearted play among friends.

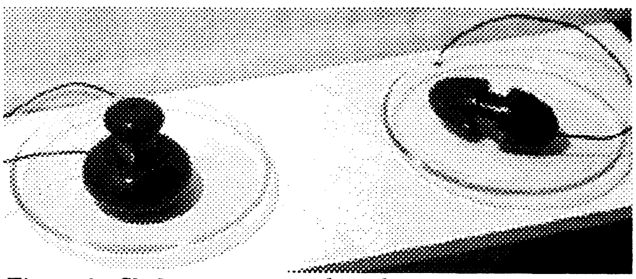

Figure 3: Shaker receiver and sender

EXPRESSIVE COMMUNICATION

Feather, Scent and Shaker have been prototyped, but only with wires connecting them, rather than full-fledged networking. Remote connections might be achieved using the internet, infrared links, cellphone, or pager technologies.

Networking will be necessary to get adequate experience, however, the current prototypes have allowed us to get a feel for the interactions these devices offer. Briefly, we feel they differ from most CSCW systems in encouraging implicit and expressive communication with a focus on supporting relationships.

Most current collaborative systems demand explicit communication. They rely on symbolic messages—usually language—which means that communicative acts must be overtly articulated by the sender, and that their reception is a relatively focused and attentional endeavour for the recipient. The use of symbols also implies that the process is one of transferring information, whether about facts or opinions or beliefs. Finally, the broad purpose of current systems is to support goal-oriented behaviour such as planning, design, or problem-solving, in which communication serves some external aim.
The emphasis on simple *awareness* taken by some media space researchers, where awareness refers to the low-level activity of keeping track of one's extended environment, contrasts with most CSCW work. One of the advantages of media spaces over more focused technologies is the ability to support this sort of immersion in a remote site. Awareness can be seen as a process of picking up largely nonsymbolic information that is not predictable nor clearly related to any particular goals. This implies that supporting awareness in collaborative software systems (e.g., shared applications or virtual realities) is difficult; the very attempt to define what information should be made available for awareness contradicts its implicit, serendipitous, non-goal-oriented nature.

Feather, Scent, and Shaker build on notions of awareness. They avoid explicit symbolism, relying instead on more immediate visual, olfactory, and tactile links. The meanings they convey can be apprehended relatively directly, because of their simplicity, their perceptual immediacy, and because the concern is not to exchange information, but rather to express mood and emotion. Finally, they are not concerned with collaboration meant to achieve external goals, but rather with companionship considered as a goal in itself. They offer very simple, poetic indications of attention and emotion that we have not seen in other collaborative systems.

Despite their nonsymbolic nature, these systems do not rely on literally imitating the everyday world to convey meaning. They use looser mappings, allowing meaning to be expressed without being explicitly defined. These mappings can be seen as metaphors, but we prefer to think of them as expression because they need not be precisely understood or defined to be effective. They depend, in part, on a significant component of product design; screen-based versions would be unlikely to have the same impact.

These prototypes are clearly preliminary, and raise many design issues. It is not clear that such simple interactions will be satisfying; instead frustrations with their minimalism may simply lead to higher phone bills. Similarly, the asymmetry of Feather and Scent seem problematic. The impact of looking at the picture object depends on knowing that one's partner might be aware; the lack of feedback might make this possibility more frustrating than fulfilling. Some utility should be offered during their resting states, perhaps by allowing manual use or other functionality. Finally, our intuitions should be tested with finished, networked versions.

These designs open new space for thinking about technology-mediated sociality. They emphasise the potential for technology to mediate interactions that are indicative rather than explicit, expressive rather than informative, and emotive rather than instrumental. The prototypes indicate that devices might be deployed that focus exclusively on these kinds of interactions. More generally, however, we believe their warmth, playfulness, and poeticism might be powerful complements to any collaborative system.