Palpability and Wearable Computing

Jessica Rajko
Stjepan Rajko
Welcome to DHSI 2017!

Thanks for joining the DHSI community!

In this booklet, you will find essential course materials prefaced by some useful information about getting settled initially at UVic, finding your way around, getting logged in to our network (after you’ve registered the day before our courses begin, and received your login information), and so on.

Given our community’s focus on things computational, it will be a surprise to no one that we might expect additional information online for some of the classes - your instructors will let you know - or that the most current version of all DHSI-related information may be found on our website at dhsi.org.

Do check in there first if you need anything that’s not in this coursepak.

To access the DHSI wifi network, simply go into your wireless settings and connect to the “DHSI” network.

And please don’t hesitate to be in touch with us at institut@uvic.ca or via Twitter at @AlyssaA_DHSI or @DHInstitute if we can be of any help ....
Digital Humanities Summer Institute  
June 2017: 5-9 + 12-16 (+ SHARP 9-12)

Saturday, 3 June 2017 [Workshop: A Brief Introduction to DH]

9:00 to 4:00  
Workshop: A Brief Introduction to DH (MacLaurin D115, Classroom)

Sunday, 4 June 2017 [DHSI Registration, Meetings, Workshops]

9:00 to 4:00  
- Full Day Workshops  
  - Data Wrangling for Digital Projects (MacLaurin D111, Classroom)  
  - Intersectionality and Surveillance (David Strong C124, Classroom)  

  ▼ Early Class Meeting: 3. [Foundations] DH For Department Chairs and Deans (David Strong C114, Classroom)  

Further details are available from instructors in early May to those registered in the class. Registration materials will be available in the classroom.

12:30 to 4:30  
DHSI Registration (NEW LOCATION: MacLaurin Building, Room A100)

1:00 to 4:00  
- 3-hour Workshops  
  - DHSI Knits: History of Textiles and Technology (David Strong C108, Classroom)  
  - Use Apache Spark to Explore and Process Large Datasets for Humanities Research (David Strong C114, Classroom)  
  - 3D Visualization for the Humanities (MacLaurin D105, Classroom)  
  - Archives for Digital Humanists (MacLaurin D010, Classroom)  
  - Dynamic Ontologies for the Humanities (MacLaurin D016, Classroom)

4:30 to 6:00  
DHSI Welcome BBQ (Get the details, and let us know you're coming, via this link!)  
After the welcome BBQ, many will wander to Cadboro Bay and the pub at Smuggler's Cove OR the other direction to Shelbourne Plaza and Maude Hunter's Pub.

Monday, 5 June 2017

Your hosts for the week are Ray Siemens and Dan Sondheim.

7:45 to 8:15  
Last-minute Registration (MacLaurin Building, Room A100)

8:30 to 10:00  
Welcome, Orientation, and Instructor Overview (MacLaurin A144)

▼ Classes in Session (click for details and locations)

1. [Foundations] Text Encoding Fundamentals and their Application (Clearihue A102, Lab)  
3. [Foundations] DH For Department Chairs and Deans (David Strong C114, Classroom)  
4. [Foundations] Fundamentals of Programming/Coding for Human(s|ists) (Clearihue A103, Lab)  
5. [Foundations] Understanding The Predigital Book: Technology and Texts (McPherson Library A003, Classroom)  
6. Out-of-the-Box Text Analysis for the Digital Humanities (Human and Social Development A160, Lab)  
7. Geographical Information Systems in the Digital Humanities (Human and Social Development A170, Lab)  
8. CloudPowering DH Research (Clearihue A012, Lab)  
9. Digital Storytelling (MacLaurin D111, Classroom)  
10. Critical Pedagogy and Digital Praxis in the Humanities (MacLaurin D105, Classroom)  
11. Text Processing - Techniques & Traditions (Cornett A229, Classroom)  
12. 3D Modelling for the Digital Humanities and Social Sciences (MacLaurin D010, Classroom)  
13. RDF and Linked Open Data (David Strong C108, Classroom)  
14. Conceptualizing and Creating a Digital Edition (MacLaurin D103, Classroom)  
15. Visualizing Information: Where Data Meets Design (MacLaurin D107, Classroom)  
16. Drupal for Digital Humanities Projects (MacLaurin D109, Classroom)  
17. Introduction to Electronic Literature in DH: Research and Practice (MacLaurin D115, Classroom)
18. Accessibility & Digital Environments (MacLaurin D101, Classroom)
19. Feminist Digital Humanities: Theoretical, Social, and Material Engagements (David Strong C124, Classroom)
20. XML Applications for Historical and Literary Research (MacLaurin D016, Classroom)
21. Open Access and Open Social Scholarship (MacLaurin D114, Classroom)
22. Ethical Collaboration in the Digital Humanities (Clearihue D131, Classroom)
24. Digital Games as Interactive Tools for Scholarly Research, Communication and Pedagogy (MacLaurin D110, Classroom)

12:15 to 1:15
Lunch break / Unconference Coordination Session
Undergraduate Meet-up, Brown-Bag (details via email)

1:30 to 4:00
Classes in Session

4:10 to 5:00
Institute Panel: Perspectives on DH (or, #myDHis ...)
Co-Chairs: Emily Murphy (Queens U) and Randa El-Khatib (U Victoria)
(MacLaurin A144)

▼ Jessica Otis (Carnegie Mellon U): "DH In The Big Tent."
Abstract: As a Digital Humanities specialist at Carnegie Mellon University, I experience the "Big Tent" of digital humanities on a regular basis. I support professors and students using everything from computer simulations for philosophical research to machine learning for studying old texts, while my own projects run the gamut from text encoding to network analysis to software containerization. For me, working in DH is a balancing act between pushing the borders of humanities knowledge while still maintaining a meaningful core of "what is DH?"

▼ David Wrisley (NYU Abu Dhabi / American U Beirut): "#myDHis messy"
Abstract: As a digital medievalist working with a textural record where orthographic variance is the norm, living in environments with complex multilingual medleys, and contributing to a number of local DH cultures across countries, my DH is perpetually messy. Some infrastructure can make things easier, but I would like to speak in praise of bricolage: making do with what you have, when you have it and for as long as you have it. Whereas some might argue that confusion is the mother of error, let us consider it instead as a necessary step towards creativity.

▼ Meaghan Brown (Folger Shakespeare Library): "#myDHis Dusty"
Abstract: As the Fellow for Data Curation at the Folger Shakespeare Library, the digital project I manage and the projects I coordinate with are deeply engaged with and indebted to our physical holdings. While Digital Humanities is often accused of being entranced with the shiny and new, I have found that descriptive bibliography and other ‘dusty’ disciplines have a great deal to offer as we create, curate, and connect digital objects. I want to ask how forms of scholarly description and organization can help us structure digital collections and think about the material implications of digital humanities work.

Abstract: An emerging critical discourse applying social justice theory and practice to digital/media scholarship is claiming growing interest. What might an intersectional framework accomplish with respect to digital humanities when an analysis with respect to race, class, gender, sexuality and difference is provided? Nieves will provide some points and reflection for further debate and discussion.

▼ Corina Koolen (U Amsterdam): "The Downside of Difference."
Abstract: Computational methods and models generally focus on differences between data sets, even though the overlap between data sets can be large. I argue that we miss part of the truth – and might even practice a form of cherry picking – when we overlook the commonalities. My argument will take the form of an example: the ‘gap’ between female and male authors in Dutch literary award nominees.

▼ Jacob Heil (C of Wooster): "#myDHis edgy and therefore slow"
Abstract: Hoping that you’ll forgive an admittedly fast-and-loose borrowing from graph theory, I want to wonder (with you) whether or not, in the work that we do and in our discourses of “collaboration,” we privilege the node over the edge. Do we think more about, say, expertise than we do about the natures of the relationships between experts? In these brief remarks I want to draw upon my experiences building up (and building upon) cultures of DH as a way of recentering the humanness of digital humanities.

▼ Michelle Schwartz (Ryerson U): "#myDHis radically inclusive"
Abstract: My entry into the digital humanities came via a community archive, rather than through traditional academia, and the focus of my work thus far has been to use DH tools to recreate the feeling of that community space online. Rather than working from a specific research question, my goal has been to use DH to make radical history relevant and accessible, and to inspire in people the joy of discovery. One starting point for that mission has been to work with undergraduate, rather than graduate students, to let those students set their own path, and to use their personal journeys to guide the project.

5:00 to 6:00
Opening Reception (University Club)
We are grateful to Gale Cengage for its sponsorship of the reception.

Tuesday, 6 June 2017
Research libraries have always played an important role in the long-term preservation of society’s documentary heritage. And while maintaining large collections of print resources over time is not without its difficulties, the challenges of managing digital materials for the long-term are enormous. New methodologies for building and sustaining our cultural heritage are being developed, and this talk will explore a variety of shared services being deployed by research libraries in Canada in support of digital stewardship and preservation activities.

Our collective cultural memory is increasingly stored in transitory bits and bytes, leading some to warn of an approaching digital dark age, where the historical record is slowly but inevitably overwritten in a thousand air-conditioned server rooms across the globe. Combine this with an environment of increasing political and environmental uncertainty, and the challenges associated with saving our cultural memory can seem daunting. So what can libraries do about it?

This presentation will define digital preservation as a complex set of systems and organizational activities required to ensure the long-term viability of digital materials over time, and provide an update.

BIO: Corey Davis is the Digital Preservation Network Manager for the Council of Prairie and Pacific University Libraries (COPPUL), a consortium of 22 university libraries in Western Canada, where he works to develop the technical and policy infrastructure to support long-term preservation of digital objects for all COPPUL members. He is also Systems Librarian at the University of Victoria Libraries.
North America and the world for drinks and appetizers in our brand new Digital Scholarship Commons. This event will take place on the third floor of the Mearns Centre for Learning /McPherson Library on Thursday June 8th from 5:30-7:30 pm. **RSVP here.**

7:30 to 9:30

(Groovy?) Movie Night (MacLaurin A144)

### Friday, 9 June 2017 [DHSI; SHARP Opening]

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<tr>
<th>Time</th>
<th>Event</th>
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<tr>
<td>9:00 to Noon</td>
<td>DHSI Classes in Session</td>
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<tr>
<td>11:00 to 1:30</td>
<td>SHARP Conference Registration (MacLaurin A100); Late registration is available at the SHARP information desk, at this same location.</td>
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<tr>
<td>12:15 to 1:15</td>
<td>DHSI Lunch Reception / Course E-Exhibits (MacLaurin A100)</td>
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<td>1:30 to 1:50</td>
<td>DHSI Week 1 Farewell (Hickman 105)</td>
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<td>2:00 to 2:45</td>
<td>SHARP Conference Opening, Welcome (MacLaurin A144)</td>
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<td>2:45 to 3:45</td>
<td>Joint Institute Lecture (SHARP and DHSI): Julia Flanders (Northeastern U): “Cultures of Reception: Readership and Discontinuity in the History of Women’s Writing.” (MacLaurin A144; the lecture will also be live-streamed, with love and care, to Hickman 105)</td>
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<td>Abstract: The work of textual recovery and republication for which the Women Writers Project is well known is to all appearances an effort to rediscover a textual and artifactual history: a history of books, once in circulation, now lodged invisibly in remote libraries and inaccessible to scholars and students, but brought back into the light by digital remediation. But the more significant and difficult rediscovery has to do with readership. In republishing these texts we are also seeking to reinsert them into a cultural landscape that has forgotten how to read them. And in republishing them digitally we are also reopening the question of what it means to read. Our challenge is to develop mechanisms of circulation that avoid reproducing the original conditions of invisibility and disappearance in which women’s writing circulated. This presentation will examine the WWP’s work on readership and reception in the context of digital technologies of reading and textual circulation.</td>
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<td>4:00 to 5:00</td>
<td>Joint Reception: SHARP and DHSI (University Club)</td>
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<td>DHSI Colloquium Poster/Demo Session</td>
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<td>SHARP Digital Demo and Poster Session</td>
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### Saturday, 10 June 2017 [SHARP Conference + Suggested Outings!]

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<th>Time</th>
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<tr>
<td>8:30 to 9:00</td>
<td>Late Registration (at the SHARP information desk) (MacLaurin A100)</td>
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<tr>
<td>8:45 to 5:00</td>
<td>SHARP Conference Sessions</td>
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<tr>
<td>5:00 to 6:00</td>
<td>SHARP Lecture: Lisa Gitelman (NYU): “Emoji Dick, Prequels and Sequels.” (MacLaurin A144)</td>
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<td>Abstract: This is the second in a sequence of talks that takes a 2010 “translation” of Moby Dick into emoji as an opportunity to consider the conditions of possibility that might delimit books and literature in the contemporary moment. A massive white codex and extended work of crowd-sorcery, Emoji Dick points toward the varieties of reading and—especially—of not reading that characterize our ever more digitally mediated and data-described world. Here I proceed by locating Emoji Dick alongside a key group of precursors and successors.</td>
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Some ideas, for those who’d like to explore the area!

- **Suggested Outing 1, Botanical Beach (self-organised; car needed)**

  A self-guided visit to the wet, wild west coast tidal shelf (and historically-significant former research site) at Botanical Beach; we recommend departing early (around 8.00 am) to catch low tide for a better view of the wonderful underwater life! Consider bringing a packed lunch to nibble-on while looking at the crashing waves when there, and then have an afternoon drink enjoying the view from the deck of the Port Renfrew Hotel.

- **Suggested Outing 2, Butchart Gardens (self-organised)**

  A shorter journey to the resplendently beautiful Butchart Gardens and, if you like, followed by (ahem) a few minutes at the nearby Church and State Winery, in the Saanich Peninsula. About an hour there by public bus from UVic, or 30 minutes by car.
**Suggested Outings**

- **Suggested Outing 3, Saltspring Island (self-organised; a full day, car/bus + ferry combo)**
  
  Why not take a day to explore and celebrate the funky, laid back, Canadian gulf island lifestyle on Saltspring Island. Ferry departs regularly from the Schwartz Bay ferry terminal, which is about one hour by bus / 30 minutes by car from UVic. You may decide to stay on forever ....

- **Suggested Outing 4, Paddling Victoria’s Inner Harbour (self-organised)**
  
  A shorter time, seeing Victoria’s beautiful city centre from the waterways that initially inspired its foundation. A great choice is the day is sunny and warm. Canoes, kayaks, and paddle boards are readily rented from Ocean River Adventures and conveniently launched from right behind the store. Very chill.

- And more!

  Self-organised High Tea at the Empress Hotel, scooter rentals, visit to the Royal BC Museum, darts at Christies Carriage House, a hangry breakfast at a local diner, whale watching, kayaking, brew pub sampling (at Spinnaker’s, Swans, Moon Under Water, and beyond!), paddle-boarding, a tour of used bookstores, and more have also been suggested!

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**Sunday, 11 June 2017 [SHARP + DHSI Registration, Workshops]**

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<tr>
<th>Time</th>
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<tr>
<td>8:30 to 9:00</td>
<td>Late Registration (at the SHARP information desk)</td>
<td>MacLaurin A100</td>
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<tr>
<td>8:45 to 5:00</td>
<td>SHARP Conference Sessions</td>
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<tr>
<td>9:00 to Noon</td>
<td>DHSI Workshop: Race, Social Justice, and DH: Applied Theories and Methods</td>
<td>MacLaurin D110, Classroom</td>
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<tr>
<td>12.30 to 5:00</td>
<td>DHSI Registration (NEW LOCATION: MacLaurin A100)</td>
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<tr>
<td>1:00 to 4:00</td>
<td>DHSI 3-hour Workshops</td>
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<td>- DHSI Knits: Using Design Technology</td>
<td>MacLaurin D010, Classroom</td>
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<td>- Intersections of DH and LGBTTIQ+ Studies</td>
<td>MacLaurin D105, Classroom</td>
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<td>- Regular Expressions</td>
<td>MacLaurin D111, Classroom</td>
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<td>- Digital Publishing in the Humanities</td>
<td>MacLaurin D101, Classroom</td>
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<td>- Steering the XPath</td>
<td>MacLaurin D103, Classroom</td>
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<td>- Crowdsourcing as a Tool for Research and Public Engagement</td>
<td>MacLaurin D107, Classroom</td>
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<td>- Web Annotation as Critical Humanities Practice</td>
<td>MacLaurin D016, Classroom</td>
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<td>5:00 to 6:00</td>
<td>SHARP Lecture: Robert Bringhurst: “The Mind-Book Problem.”</td>
<td>MacLaurin A144</td>
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<td>6:00 to 9:00</td>
<td>SHARP Banquet</td>
<td>University Club</td>
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**Monday, 12 June 2017 [SHARP + DHSI]**

Your hosts for the week are Alyssa Arbuckle, Ray Siemens and Dan Sondheim.

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<th>Time</th>
<th>Event</th>
<th>Location</th>
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<tr>
<td>7:45 to 8:15</td>
<td>DHSI Last-minute Registration</td>
<td>MacLaurin A100</td>
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<tr>
<td>8:30 to 10:00</td>
<td>DHSI Welcome, Orientation, and Instructor Overview</td>
<td>MacLaurin A144</td>
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### 8:45 to 4:00
SHARP Conference Sessions

<table>
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<tr>
<th>Time</th>
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<tbody>
<tr>
<td>8:45 to 9:00</td>
<td>DHSI Classes in Session (click for details and locations)</td>
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<tr>
<td>8:45 to 4:00</td>
<td>25. [Foundations] Intro to Computation for Literary Criticism (Clearihue A105, Lab)</td>
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<td>8:45 to 4:00</td>
<td>26. [Foundations] Developing a Digital Project (With Omeka) (Cornett A229, Classroom)</td>
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<td>8:45 to 4:00</td>
<td>27. [Foundations] Models for DH at Liberal Arts Colleges (&amp; 4 yr Institutions) (MacLaurin D109, Classroom)</td>
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<tr>
<td>8:45 to 4:00</td>
<td>28. [Foundations] Introduction to Javascript and Data Visualization (Clearihue D131, Classroom)</td>
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<td>8:45 to 4:00</td>
<td>29. Wrangling Big Data for DH (Clearihue A108, Lab)</td>
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<td>8:45 to 4:00</td>
<td>30. Stylometry with R: Computer-Assisted Analysis of Literary Texts (Clearihue A102, Lab)</td>
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<td>8:45 to 4:00</td>
<td>31. Sounds and Digital Humanities (MacLaurin D111, Classroom)</td>
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<td>8:45 to 4:00</td>
<td>32. Digital Humanities Pedagogy: Integration in the Curriculum (Cornett A121, Classroom)</td>
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<tr>
<td>8:45 to 4:00</td>
<td>33. Creating LAMP Infrastructure for Digital Humanities Projects (MacLaurin D107, Classroom)</td>
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<td>8:45 to 4:00</td>
<td>34. Understanding Topic Modeling (MacLaurin D105, Classroom)</td>
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<tr>
<td>8:45 to 4:00</td>
<td>35. Palpability and Wearable Computing (MacLaurin D016, Classroom)</td>
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<td>8:45 to 4:00</td>
<td>36. Building a Professional Identity and Skillset in the Digital Humanities (MacLaurin D101, Classroom)</td>
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<td>8:45 to 4:00</td>
<td>37. Digital Editing with TEI: Critical, Documentary and Genetic Editing (MacLaurin D114, Classroom)</td>
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<td>8:45 to 4:00</td>
<td>38. Understanding Digital Video (MacLaurin D103, Classroom)</td>
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<td>8:45 to 4:00</td>
<td>39. Beyond TEI: Metadata for Digital Humanities (David Strong C114, Classroom)</td>
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<td>8:45 to 4:00</td>
<td>40. Extracting Cultural Networks from Thematic Research Collections (Clearihue D132, Classroom)</td>
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<td>8:45 to 4:00</td>
<td>41. Digital Public Humanities (MacLaurin D010, Classroom)</td>
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<td>8:45 to 4:00</td>
<td>42. Using Fedora Commons / Islandora (Human and Social Development A160, Lab)</td>
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<td>8:45 to 4:00</td>
<td>43. Practical Software Development for Nontraditional Digital Humanities Developers (David Strong C124, Classroom)</td>
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<td>8:45 to 4:00</td>
<td>44. Documenting Born Digital Creative and Scholarly Works for Access and Preservation (MacLaurin D115, Classroom)</td>
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<td>8:45 to 4:00</td>
<td>45. An Introduction to Computational Humanities: Mining, Machine Learning and Future Challenges (MacLaurin D110, Classroom)</td>
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<td>8:45 to 4:00</td>
<td>46. Games for Digital Humanists (David Strong C108, Classroom &amp; Human and Social Development A170, Lab)</td>
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<td>8:45 to 4:00</td>
<td>47. Introduction to XSLT for Digital Humanists (Cornett A128, Classroom)</td>
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<tr>
<td>8:45 to 4:00</td>
<td>48. Documenting Born Digital Creative and Scholarly Works for Access and Preservation (MacLaurin D115, Classroom)</td>
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<td>8:45 to 4:00</td>
<td>49. An Introduction to Computational Humanities: Mining, Machine Learning and Future Challenges (MacLaurin D110, Classroom)</td>
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<td>10:15 to Noon</td>
<td>DHSI Undergraduate Meet-up, Brown-Bag (details via email)</td>
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<td>12:15 to 1:15</td>
<td>DHSI Lunch break / Unconference Coordination Session</td>
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<td>1:30 to 4:00</td>
<td>DHSI Classes in Session</td>
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<td>4:10 to 5:00</td>
<td>Joint Institute Lecture (SHARP and DHSI): Brewster Kahle (Internet Archive) and Jo-Ann Roberts (CBC): &quot;A Conversation with Brewster Kahle, moderated by Jo-Ann Roberts.&quot; Chair: Jonathan Bengtson (U Victoria) (MacLaurin A144; the conversation will also be live-streamed, with love and care, to Hickman 105)</td>
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<td>5:00 to 6:00</td>
<td>Joint Reception: SHARP and DHSI (University Club)</td>
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### Tuesday, 13 June 2017

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<td>9:00 to Noon</td>
<td>Classes in Session</td>
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<tr>
<td>12:15 to 1:15</td>
<td>Lunch break / Unconference &quot;Mystery&quot; Lunches</td>
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<tr>
<td>1:30 to 4:00</td>
<td>Classes in Session</td>
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<td>4:15 to 5:45</td>
<td>DHSI Colloquium Session 4 (MacLaurin A144)</td>
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<td>6:00 to 8:00</td>
<td>DHSI Newcomer's Beer-B-Q (Smuggler's Cove)</td>
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### Wednesday, 14 June 2017

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<td>9:00 to Noon</td>
<td>Classes in Session</td>
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<tr>
<td>12:15 to 1:15</td>
<td>Lunch break / Unconference &quot;Mystery&quot; Lunches</td>
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### Thursday, 15 June 2017

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<tr>
<td>1:30 to 4:00</td>
<td>Classes in Session</td>
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<tr>
<td>4:15 to 5:45</td>
<td>DHSI Colloquium Session 5 (MacLaurin A144)</td>
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<td>6:00 to 7:00</td>
<td>“Half Way There (yet again)!” Birds of a Feather Get-Together (Felicitas, Student Union Building)</td>
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### Friday, 16 June 2017

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<tbody>
<tr>
<td>9:00 to Noon</td>
<td>Classes in Session</td>
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</table>
| 12:15 to 1:15 | Lunch break / Unconference **Mystery** Lunches  
Instructor lunch meeting |
| 1:30 to 4:00  | Classes in Session                                                    |
| 4:15 to 5:45  | DHSI Colloquium Session 6 (MacLaurin A144)                            |
| 7:30 to 9:30  | (Groovier?) Movie(r) Night (MacLaurin A144)                          |

**Abstract:** The Digital Humanities have developed in two main institutional contexts: within dedicated research centers and within more traditional discipline-based faculties -- with those in the former case in danger of closing themselves within ivory towers of a think-alike community and the “lone wolves” of the latter case most likely to have suffered isolation and lack of real engagement with their peers. More recently, these disparate experiences are seeing some convergence as, slowly but steadily, DH has raised its profile and its impact within the Humanities, with external and internal pressure on other fields now mounting (as demonstrated by intensification of newspapers articles, manifestos and positions being advertised). We are now at a turning point: will the experience of DH feed back and enrich disciplines such as English, Spanish, History, and so on, or will brand new disciplines stem from it, as has happened for Computational Linguistics as a clearly separated entity with respect to Linguistics? These are some of the questions that this lecture will address.

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<td>2:45 to 3:00</td>
<td>Closing, DHSI in Review (MacLaurin A144)</td>
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Palpability and Wearable Computing

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**Course Description**

Wearable technology (WT) is moving closer to and even into the human body, effectively rendering it invisible. Coined by Mark Weiser as Invisible Computing, wearable technologies now "weave themselves into the fabric of everyday life until they are indistinguishable from it." While technologies may appear invisible to the naked eye and continue to demand less of our visual attention, our understanding of the world is created not just through our eyes but through our multisensory, bodily experiences. Therefore, this movement of technologies from our hands onto our skin should, but often does not account for our broader, felt experiences. In this course we will explore the central role of the palpability, of feeling of our active senses, in WT design.

Participants are asked to read the materials in this course packet before the seminar begins. The selected of readings cover the history, contemporary human-computer interaction design theory, and practices in embodied computing, personal affective computing, invisible computing, and somatic practices (body/mind integration). This course will engage students with small movement explorations to bring awareness to the rich information provided through our active, seeking senses. We will also spend significant time tinkering with wearable technologies and dreaming up designs for new WT through hands-on play. Participants will be able to play with existing wearable technologies as well as various wearable microcontrollers, sensors and feedback output devices. No prior movement experience is assumed, but participants should come wearing comfortable clothing for movement explorations.
Outline

Monday
Introduction to Somatic Practices, Wearable Technology, and Real-time Processing

- Morning (10:15 – 12:00)
  - Introduction to somatic practices: attuning our awareness to bodily sensation
  - Introduction to wearable technologies: an analogue introduction

- Afternoon (1:30 – 4:00)
  - Getting setup: downloading software and learning about the digital side of our wearable tech
  - Introduction to real-time processing: embodying sensing, analysis, and feedback loops

- Readings:
  - Ch. 1, Gymnastik for People Whose Lives Are Full of Activity by Elsa Gindler
  - “The Action in Perceiving,” Interview with Bonnie Bainbridge Cohen by Nancy Stark Smith and Simone Forti
  - Viewing: Jill Bolte Taylor’s Ted Talk: “My Stroke of Insight”
  - Thecla Schiphorst, “Between Bodies: using Experience Modeling to Create Gestural Protocols for Physiological Data Transfer”

Tuesday
Witnessing our somatic experiences: Deconstruction and Bricolage

- Morning (9:00 – 12:00)
  - Deep listening: hearing our own bodies, our space, and each other
  - Learning how to see: deconstructing habits of seeing

- Afternoon (1:30 – 4:00)
  - The primacy of touch: experiencing the complexity of touch
  - Bricolage: engaging in multisensory experiences

- Readings and Viewings:
  - Missy Vineyard, “How you Stand, How you Move, How you Live,” Ch. 13 Believing is not Seeing
  - Thomas Fuchs and Sabine C. Koch, “Embodied affectivity: on moving and being moved”
  - Viewing: Deborah Hay interview on consciously seeing
Wednesday
Embodied Critique of Consumer WT and Computational Processes

• Morning (9:00 – 12:00)
  o Experiencing our intertwined systems: debunking the mind/body split

• Afternoon (1:30 – 4:00)
  o Unboxing consumer wearable technologies: a somatic approach to unraveling implicit bias
  o Imagining new possibilities: dreaming wearable tech experiences from a somatically informed lens

• Readings and Viewings:
  o Susan Elizabeth Ryan, “Garments of Paradise,” Ch. 3 Invisible Interface
  o Moira Weigel, “Fitted”
  o Viewing: Joy Boulamwini, How I’m Fighting Bias in Algorithms

Thursday
Re-imagining Wearable Tech (Considering Somatic Design Practices)

• Morning (9:00 – 12:00)
  o Playing with technologies: Small group sessions learning different wearable tech design processes

• Afternoon (1:30 – 4:00)
  o Play session: continue imagining new wearable tech experiences from a somatically informed lens

• Readings:
  o Phoebe Sengers, “The Engineering of Experience”
  o Paul Dourish, “Where the Action Is: The Foundations of Embodied Interaction,” Ch. 6, Moving Toward Design
  o www.unfitbits.com

Friday
Re-imagining Wearable Tech (Continued)

• Morning (9:00 – 12:00)
  o Play session: continue imagining new wearable tech experiences from a somatically informed lens

• Afternoon (12:15 – 1:15)
  o Presentation at lunch reception
Physical Engagement

Most of our time is going to be spent moving and making stuff together, rather than reading or talking about reading. This means two things:

First, that you shouldn’t wear your best clothes to class. Please wear comfortable clothing that you can physically move in. We will be sitting and lying on the floor, so pants are recommended. Layers are also recommended for some of the quieter somatic work. You are also more than welcome to bring a towel or small blanket. Movement will be open and exploratory, and you will be encouraged to work at your own pace. With that said, if you have any prior injuries or physical concerns, please notify us on the first day. We are accustomed to providing modifications to movement and meeting each student and her/his own comfort level.

Second, physical engagement is key. The readings provided in this coursepak are intended to give you some background context, but they cannot provide you with the same knowledge learned through hands-on experience. The best way to learn in this course is through active exploration. Physical engagement will be applied to both the movement explorations and the tinkering. We will encourage you to explore materials through physical engagement first. Again, no prior experience is necessary!

Critical Self-Study

This class will engage students in rigorous self-study. Somatic practices are largely based on understanding one’s own embodied experience, and as such, students will engage in many activities that will encourage self-exploration. A large section of this coursepak is dedicated to note taking. We encourage students to document their own embodied experiences both within and outside of class. Students will be given various prompts for writing and time to engage in written reflection throughout the class. If the space provided within the coursepak is not enough, we encourage students to bring their own journals.
Useful definitions

**Somatics** is a growing field that encompasses many different disciplines focused on the dialogue between inner and outer experience in relation to the whole person. The word Somatics comes from the Greek root soma, meaning "the living organism in its wholeness." Somatics offers a way to understand human beings as an integrated mind/body/spirit, and as social, relational beings.

**Kinesthetic awareness** is often associated with the internal sensation of moving, kinesthetic awareness is present whether one is active or passive. It relates to our sense of weight in relation to gravity, resistances to movement or weight, and the relative positions of the body in relation to itself or the environment.

**Spatial awareness** is our sensitivity to our surrounding environment, the position of the head and body in relation to the earth, and the direction of our own motion, and the direction of others’ in space.

**Somatic awareness** includes attending to our external senses (sight, hearing, tasting, smelling and touching) as well as to our proprioception or the sensing of our movements.

**Visceral awareness** is our sensitivity to the changes within our internal organs expressing levels of excitation and fatigue.

**Proprioception** guides our senses in the world and underlies our capacity for orientation. It encompasses all aspects of movement and includes: kinesthetic, spatial, and visceral awareness.

**Embodiment** is the cells’ awareness of themselves. “You let go of your conscious mapping.” It is a direct experience; there are no intermediary steps or translations. There is no guide, no witness. There is fully known consciousness of the experienced moment initiated from the cells themselves. In this instance the brain is the last to know. There is complete knowing; there is peaceful comprehension. Out of this embodiment process emerges feeling, thinking, witnessing, understanding and the readiness to create.

**Somatization** is the process by which the kinesthetic (movement), proprioceptive (position), and tactile (touch) sensory systems inform the body that the body exists. In this process there is a witness, an inner awareness of the process. For instance, you become directly aware of the sensation emanating from a part of the body through movement and/or touch; or you initiate movement from a place in the body and are aware of the sensations and feelings that arise. “What do you notice? What are your sensation, feelings, perceptions? How does this affect your movement and your consciousness?”

**Definitions by visual artist/choreographer RoseAnne Spradlin**
Hardware

You will have the opportunity to play with several different microcontrollers, sensors, and feedback devices throughout the five days of this class. We will be doing some wearable construction throughout the final course days, but most of the building has already been done (by the instructors) in advance. This ensures that we can spend most of our time exploring and generating ideas through embodied exploration, rather than focusing on how to make it work. Below is a list of the hardware components we'll be exploring. If we add any additional hardware, we'll bring handouts with details to the first day of class.

Microcontrollers & Wireless Communication

The Thing: Intended for Internet of Things (IoT) projects, this board allows for data to be transmitted and received wirelessly via the wifi. Great for communicating to external devices without having to be tethered via USB.

https://www.sparkfun.com/products/13231

Sensors

LSM9DS0, 9-dof sensor: This sensor provides accelerometer, gyroscope and magnetometer data along 3 axes, for a total of 9 degrees of freedom. Circular, this sensor was specifically designed for wearable projects.


BNO055, Absolute Orientation Sensor: This is a 9-dof sensor with preinstalled digital signal processing algorithms that calculate the sensor’s 3D spatial position/orientation.

https://learn.adafruit.com/adafruit-bno055-absolute-orientation-sensor

MAX4466, Electric Microphone Amplifier: As the name reads, this is a microphone. This sensor can be used to record/sample sound or react to
environmental sounds.

https://www.adafruit.com/products/1063

**TSL2561, Luminosity Sensor**: Also known as a light sensor, this sensor reads brightness or luminosity.

https://learn.adafruit.com/flora-lux-sensor/overview

**TCS34725, RGB Sensor**: This is a color sensor that can read the color of an object within its range.

https://www.adafruit.com/product/1356

**Feedback devices**

**Neopixel**: Smart LEDs. Each neopixel is an RGB LED that can be independently controlled through a single data line.

https://www.adafruit.com/products/1260

**Disc Motors**: Small vibrating motors that can be used to provide haptic (touch-based) feedback.

https://www.adafruit.com/products/1201
Software

We will use the following software in this class. You are not expected to have prior experience with the software listed below. All versions of the software we use are free and should be downloaded in advance.

Arduino Software
Download here: https://www.arduino.cc/en/Main/Software

About: We will use this software to program our microcontrollers. While this is the foundational software program for Arduino microcontrollers, many other microcontroller boards (such as the Flora) have adopted Arduino's software program language.

Arduino Plugins and Drivers
There are a few plugins and drivers required for the hardware we're using in this class. Please install the following plugins and drivers prior to the seminar.

ESP8266 Sparkfun Thing Arduino Addon

Neopixel Library
https://learn.adafruit.com/adafruit-neopixel-uberguide/arduino-library

TSL2561 and Adafruit Sensor Libraries
https://learn.adafruit.com/flora-lux-sensor/programming

Max/MSP 7.1
Download Here: https://cycling74.com/downloads/

About: Max/MSP is a software design platform often used for real-time signal processing. For our purposes, it allows us to input sensor data and process it in real-time to control and manipulate image/sound/video. https://cycling74.com/

Free 30-day Trial: If you've never downloaded Max/MSP before, then you automatically get access a free 30-day trial. NOTE: This is not required to participate. After 30 days, you can still access patches, but you cannot save new edits. We will be bringing in working patches that you can play with.
Elsa Gindler

The late Elsa Gindler (1885–1961) is known throughout the world for having created a radically simple way of working with experience, a Western form of meditation, in which participants learn simply how to pay attention—to eating, standing, walking, speaking, lifting a stone. Her school flourished between the two wars in Berlin. Partly in reaction to Nazi demands, she refused to give her work a name. Sometimes she called it "Human Work," or "Unfolding at a later stage of life." All of her writings save this one were destroyed when her studio was burned by Nazi soldiers during the final months of the war. Her teachers have disseminated her work throughout the world. The best known are Dr. Lilly Ehrenfried who took the work to France, and Carola Speads and Charlotte Selver who brought it to the United States.
Gymnastik for People
Whose Lives Are Full of Activity

Elsa Gindler

It is difficult for me to speak about Gymnastik because the aim of my work is not the learning of certain movements, but rather the achievement of concentration. Only by means of concentration can we attain the full functioning of the physical apparatus in relation to mental and spiritual life. We therefore advise our students from the very first lesson that our work must be pursued consciously; it can only be entered into and understood through consciousness.

Now it becomes ever more and more apparent to all of us that we do not quite keep up with our lives—that the balance of physical, spiritual and intellectual forces is disturbed. In most cases this disturbance already begins to happen in the school years. Then, beyond the problems of school and puberty, problems in family relationships and profession—and perhaps misfortune—bring us difficulties with which we can no longer cope. We no longer lead our lives thoughtfully and sensitively. We become rushed and allow confusions around and within us to accumulate in such a way that they get the upper hand at very inappropriate moments.

Inadequacy dominates us in general and in particular. Daily there are the same, small, endless, infinitely important mishaps. In the morning we are not rested and therefore get up just that much too late to permit ourselves to take care of our body with the calmness and quickness which would fill us with well-being and vigor. It is not without reason that we say, “I must bathe, I must brush my teeth (drink coffee, go to the theater, a party, etc.)” instead of, “I am going to brush

my teeth, etc." These expressions reveal something important—that we do everything in order to be finished with it, and then the next thing that must be done comes along. If a room is cleaned for the purposes of getting through with it, it looks different from the room that has been cleaned with the sense of having it clean and orderly. And how extraordinary: the success is so much greater with the latter yet no more time is needed. On the contrary, we become able to reduce the time for a task while substantially increasing the quality of the results.

We also come into a state that is more human because, when a task is executed thoughtfully, and when we are contented with ourselves in the doing, we experience consciousness. By that I mean consciousness that is centered, reacts to the environment and can think and feel. I deliberately avoid defining this consciousness as soul, psyche, mind, feeling, subconsciousness, individuality, or even the "body-soul." For me, the small word "I" summarizes all this. And I always advise my students to replace my words with their own (those words which they use in talking to themselves) in order to avoid getting a knot in their psyche and having to philosophize for hours about what was really meant. In that same time they could be doing something useful.

It may be regarded as a somewhat presumptuous to wish to approach the attainment of consciousness by means of Gymnastik. And it really is! We are always embarrassed when this work is called Gymnastik. Most people have become accustomed to regard Gymnastik as certain exercises, so the first question put to us is always about our "typical exercises." To this we can only reply that our work is not Gymnastik in the ordinary sense, which certainly does not bring about consciousness: what does the mind that is present and concentrated on the situation.

In general people think, "When I have learned the relaxation exercises I am relaxed; if I can do the breathing exercises I can breathe; when I do the swinging exercises I work with dian; and when I have learned how to correct bow-legs or knock-knees, they will be straight." This is not true, and we invariably see failure resulting from this naive opinion.

It is clear that merely learning and doing these Gymnastik exercises cannot lead to the attainment of full consciousness. How do we get closer to that? Simply by using all our spirit and feeling in bringing our body closer to be a responsive instrument for living. We see to it that our students do not learn an exercise; rather, the Gymnastik are a means by which we attempt to increase intelligence. When we breathe, we do not learn fixed exercises, rather, exercises are the means of our getting acquainted with the workings of our lungs, either through inducing or releasing holdings. When we become aware that our shoulder-girdle is not in a position where it works easily we do not put it into the correct position from without. That does not really help anything, for as soon as the person is busy with something else he forgets his shoulder-girdle. Admittedly these are people who can clench and hold it in just the "right" place, but then that's just what it looks like—like clenching.

Usually we start a course by asking our students what they want to work on. In the beginning the result is shocking. Either nobody says anything, or somebody says, "You should get rid of my stomach," and other similar requests. The first stumbling-block is when I answer that I would not think of getting rid of someone else's stomach; the person would have to do that for himself.

Let us assume it has been decided to work on the shoulder girdle. We carefully examine it as to detail of form and usage. With the help of a skeleton we find out how it can best fulfill its function. We compare our functioning with that of the skeleton and then work to find out what has to happen within ourselves to come closer to such functioning.

In most instances, and especially during the beginning sessions, we work blindlyfolded so that each person is trying, by himself, to determine from where the holding of a wrong position originates, and what hinders the shoulder-girdle from finding the right position. Suddenly, each student is working in his own fashion. That means that each one in the class works differently, with a pervading concentration and quiet that would be envied in many lecture halls.

The leader notices at once where something goes amiss. He sees, for instance, how some students have a talent for always choosing the
most difficult and problematic tasks. It is the business of the leader to point out that one reaches an objective by using the simplest and easiest experiments. In each course, however, we work with completely different exercises, inventing new ones as it goes along.

In this manner we accomplish something essential. The student begins to feel that he is in charge of himself. He suddenly feels that if he wishes he can work on his whole body in the same manner that he worked on his shoulder-girdle. His consciousness of self is heightened, he is no longer confused by the range of the subject matter, he is encouraged. This is a state which cannot be attained by exercises alone, regardless of how thought-out they may be.

So much for our way of working. Now to the areas of learning, which are breathing, relaxation, and tension—words often mused as are all beautiful things in the world. As long as they remain just words, they create mischief; as soon as they are imbued with experience they become great mediators of life.

One of the most delicate and difficult areas of our work is breathing. As we can see among small children and animals, every movement can increase and deepen breathing. Among adults, however, whose physical, spiritual, and mental processes are no longer governed by the unity of consciousness, the relationship between breathing and movement is disturbed. And almost all of us are in this situation. Regardless of whether we want to speak, make a small movement, or think, we impede breathing. Even while resting we impede it. We need only to consider how freely the neck emerges from the trunk of most animals, and, in a quiet moment, compare our own neck to theirs. Usually we will find that our neck is being pulled considerably inward from the middle of the body, approximately from the diaphragm. When this interconnection is observed for a longer time, it will be noticed that this cramping is quite arbitrary and that when one lets it go, one suddenly feels that the neck can be held much more freely. The constriction in the aistream through the neck (that occurs in almost everyone) suddenly ceases, and one feels much freer. At any time when this can be consciously permitted one feels not only that movements will not disturb the breathing, but can increasingly deepen it. Instead of becoming tired, one becomes refreshed by work. If this were translated to living, we would become more and more refreshed and productive the more demands are made upon us.

Actually, we imagine life to be that way, and we see over and over again that people who accomplish the most are fresher than those who do nothing. And if we observe successful people we can often see that they display a wonderful flexibility in reacting, in constantly changing from activity to rest. They have flexible breathing, or functional breathing. This is not easily attainable. Our students repeatedly confirm with little satisfaction that they need only think of an activity to feel how they immediately become rigid and impede their innate capacities. One is so used to doing it that it is difficult to abandon this nonsense.

In difficult situations—for example in marital quarrels or with the unexpected appearance of one’s employer—we see that this gasping for breath and cramp in the diaphragm and stomach regions assumes frightening dimensions. Breathing stops, or a breath is hastily drawn, and the situation—which probably demands our greatest responsiveness—is hopelessly lost. We all know this condition well: embarrassment, anxiety, ill-humor, confusion in the mental and spiritual realms; trembling or an embarrassed fidgeting with arms and legs in the physical realm. If one is already conscious of how cramping—or constriction—can be eliminated by becoming aware of it, one is suddenly equal to the situation. The breath flows more freely, the mental confusion abates, one can make use of one’s capacities.

It is clear that we cannot begin by working with large movements if even the smallest cause interference with the natural flow of breathing. One must first come to know—through observing oneself—just what one does with breathing while brushing one’s teeth, while putting on one’s socks, or while eating. So we begin by attempting to waken in our students an understanding of what happens in these daily performances. Then we have them try to make any movement without interfering with breathing. This requires so much work that one could probably stay with it forever. The main playground for this practice, however, is not the class session—there the release of constricted breathing is attained relatively easily and quickly. It is in life outside the classroom where we must notice how breathing becomes constricted in response to the most trivial causes; it is there where the
COMING TO OUR SENSES

tendency to constrict must be overcome. Simply noticing the con-
striction already brings help, and the more often we notice it, and the
more we accustom ourselves to investigating whether it is not per-
haps an interference with breathing, the more easily and naturally it
will be relieved. Small happenings allow us more time to do this than
will be. In any case we will begin to feel the beneficial effects
of the big ones, but in no case will we be able to feel the beneficial
effects of the small ones. The air does not and cannot enter the lungs freely because the small lung vesicles have not yet opened. And it is these that must be supplied with oxygen while breathing. Access to them, the smallest bronchial, is provided by vessels more delicate than hair, so naturally the attempt to press the dammed-up air into them must fail. In addition, it often occurs that the air vesicles, at the time when the air is prematurely pumped in, have not yet emptied themselves of the old supply of air. They now do that, and the air stream trying to work upward and outward from inside collides with the air being pumped in from the outside so that there occurs a kind of piling up, and the result is a pressed, constricted feeling. But if we wait for the opening of the smallest vesicles we thereby permit a pause to occur completely. Then, as soon as the vesicles become empty, they suck in air automatically. The air then easily penetrates the smallest, hair-like vessels. Nowhere does congestion occur, and nowhere is there a sensation of thickness or of lack of air. We do not need to bring into action any special activity for inhalation.

This is the difference between the breathing that occurs when the lungs and vesicles are open and breathing which occurs through the arbitrary inhalation of air. The difference for movement is very signif-
ican. If movement is undertaken during arbitrary breathing—i.e.,
while air is being pumped in—it will not be alive and will get no feel-
ing of movement. If the movement occurs with open breathing, the movement becomes alive.

For releasing people from constrictions, only those movements can be fruitful which are connected with conscious and spontaneous breathing or, to state it more specifically, with breathing which happens through open vessels. Anything else would be more likely to disturb the collaboration between breathing and movement and to increase the habit of excessive and inappropriate effort. This is an
additional reason compelling us to carefully assess any movements to be used in releasing constriction. For example, it makes running for which much inhalation of air is necessary, seem unsuitable. The tendency is to pull in air—which does not help supply the lungs with air, nor assist in eliminating the deficiency of oxygen resulting from running. If we practice running in our work, we start by doing so for such a short time that we can run with open breathing, then gradually increase the time.

An adequate supply of air is necessary and helpful in every task. It is not possible to swim or even float quietly without the ability to provide the lungs with air. When swimming, the lungs can gradually come close to this if we observe ourselves continually in daily life, preferably on minor occasions. Thinking about it, alone, will not bring us a step closer. We must just open our senses to these phenomena.

When the student has learned to react with breathing to the small stimuli, and has come to improved functioning of the lungs, a new task emerges spontaneously—that of bringing the entire lungs to more working. Almost all of us use only a small part of the lungs in breathing. If this small part functions well, as has been described, we can accomplish much in life. However, in our work it is clearly shown that, if we engage the full capacity of the lungs in working, we can increase our efficiency significantly. And here begins the education in exhalation. It must take place without pressure, it must be elastic, it must be like the gentlest breeze, and it must bring about the greatest possible emptying.

In the course of these considerations we have often used the word "constriction" or "cramping" and must go into this topic in greater detail. I have tried to show to what a great extent constriction is bound up with disturbances in breathing and these, once again, with disturbances in the psychic realm. Releasings, or relaxations, are hence utterly dependent upon our being able to create a living image of the state of relaxation and of realizing it through suitable exercises.

For us relaxation is that condition in which we have the greatest capacity of reacting. It is a stillness within us, a readiness to respond appropriately to any stimulus. We read that the Arabs have a capacity through which, after long hours of trekking through the desert, they can lie motionless on the sand for ten minutes, and in this ten minutes to regenerate themselves so that they are then able to continue walking for hours longer. This is an example of relaxation. We hear that top businessmen often remain utterly motionless for a moment while directing all their senses inward. Then, suddenly, they seem to awaken and make decisions that are uniquely right. It is clear that in this moment of being in themselves relaxation has taken place. This is the kind of relaxation we are seeking. It can be most readily reached through the experience of gravity.

It is gravity which our limbs must learn to feel and understand. Indeed, every cell in us must once again become able to respond to gravity. Who of us, for instance, is truly relaxed as we lie in bed before going to sleep—responding to gravity as does a sleeping animal? When we attempt to feel the weight everywhere in the body, even in the head, we get into a state where nature takes over the work for us. To the extent that we can come to a way of lying in which this state is possible, natural breathing will occur—not arbitrary breathing with great movements of the chest, but a quiet breathing where the breath flows imperceptibly back and forth and brings sleep.

As for standing—real standing—we must feel how we give our weight, pound for pound, onto the earth, and how in doing so the feet become steadily lighter. Here is a paradox: the more weighty we become the lighter we become and the quieter we become.

In sitting we must be upright. As long as we slouch, we disturb all the internal functions. When one straightens up, one can feel how breathing immediately becomes quieter and more satisfying. It can often be observed how people who are bored or fatigued, in order to come to themselves, take a good strong stretch out of the crooked position. In sitting the joints will be freely movable, and there will be plenty of room for the stomach to function and for the spine to stretch itself to its full extension. If we then swing the torso forward at the hip joints, there is an expansion of the upper portion of the lungs, the
same expansion we find so beneficial in swimming and especially in walking against the wind.

Now a word about tension, our third area of study. It may seem that tension comes off rather poorly in our work, but I must say that it only seems that way. Healthy tension is for us in the greatest contrast to constricting. We gladly give ourselves a work-out, but we do not wish to wear ourselves out—and that is where the difference lies. In reality, whoever is truly able to relax is also capable of healthy tension. This we perceive as the beautiful changeability of energies that react to every stimulus, increasing and diminishing as required. Above all, it includes the strong feeling of inner strength, of effortlessness in accomplishment—in short, a heightened joie de vivre. Healthy tension as we understand it is the possibility of overcoming the greatest obstacles with the greatest ease through the power of heightened breathing.

Generally speaking, in all of this, the most essential things we have to keep in mind are: that any correction made from without is of little value, and that each of us must try to gain understanding for the special nature of our own constitution in order to learn how to take care of ourselves.

Charlotte Selver

Charlotte Selver came to the United States in 1938 as a refugee, and soon managed to earn a living teaching the Gindler work in New York. Her early students included Fritz Perls, Alan Watts, and Erich Fromm. She has had a major influence on Humanistic Psychology and was the first person to lead workshops at Esalen Institute. The radical simplicity of her work led to her being invited to be a regular teacher of Zen students. At the time of this writing, she is ninety-four years old and still traveling to Europe, Maine, and Mexico teaching her work to which her vitality and acuity are better testimony than any possible research could yield.
The Action in Perceiving

In this article I would like to look at the other side of our Spring/Summer '84 CQ article, "Perceiving in Action," to explore the dynamic activeness of perceiving.

Some of the concepts that I would like to share are that movement is a perception; that it is the first perception to develop and therefore the most important for survival; that as each experience sets a baseline for future experiences, movement helps to establish the process of how we perceive; and that how we perceive movement becomes an integral part of how we perceive through other senses.

First, we need to differentiate between sensing and perceiving. Sensing is the more mechanical aspect, involving the stimulation of the sensory receptors and the sensory nerves. Perceiving is about one's personal relationship to the incoming information. We all have sense organs which are similar, but our perceptions are totally unique. Perception is about how we relate to what we're sensing. Perception is about relationship—to ourselves, others, the Earth and the universe. And it contains the interweaving of both sensory and motor components.

Traditionally, people speak of the sensory-motor or perceptual-motor process. In this approach, sensory and perceptual relate to the incoming information and motor relates to the outward movement response to the sensory stimuli.

In this traditional model, after the reception of the information (sensory aspect) there is the perceptual processing, which compares the new information with all previous experiences and interprets the stimuli. Then there is a motor-planning phase, in which one organizes a motor response, and then there is the actual movement response itself. Finally, there is the sensory feedback, which provides information about what happened during the response and then our interpretation and feelings about what took place, i.e., its relationship to us, from our viewpoint. This process is called the sensory-motor loop and its phases can be outlined as follows:

Sensory input — Perceptual interpretation — Motor-planning — Motor response — Sensory feedback — Perceptual interpretation

In working with this model for over twenty years, I have found that there are two more phases which are essential for facilitating change by creating the possibility for more choices.

To understand these new phases requires an alternative approach to the traditional concept of perceptual-motor or sensory-motor process. This new approach recognizes that both the input and output aspects of the stimulus/response loop have both motor and perceptual activity. This approach also requires an expansion of the traditional list of "the 5 senses": touch, taste, smell, hear, and vision.

It is fascinating and, I must confess, frustrating to me that the sensations of movement and visceral activity have been excluded from this grouping of the major senses. And all sciences are reflections of the socio-political-religious ideas of their time, it is appropriate that the historical repression of bodily sensation in Western Culture has been transmitted as a matter of scientific fact. Within this view, a phenomenon is usually only considered to be "objective scientific fact" if it can be separated from all bodily sensations, i.e., it must be capable of being measured only auditorily and/or visually. If it is measured by bodily sensation, it is considered to be "subjective" and "not scientific." The experience of movement is not considered to be a "scientific study."

In universities throughout this country, in movement science programs, such as Motor Learning and Exercise Physiology, the actual movement has to be separated from all bodily sensation in order to be studied or validated. Most of these programs do not even offer movement classes. Movement is studied via reading and video.
MOVEMENT IS THE FIRST PERCEPTION

There are twelve pairs of cranial nerves which process three major types of information:
• special senses of the head—touch to the head, taste, smell, hearing, and vision
• movement of the whole body
• visceral activity

Of all these cranial nerves, the first pair to myelinate (develop a fatty insulating covering) are the Vestibular Nerves.

Nerves myelinate in order of their importance for survival. The Vestibular Nerves begin to myelinate in utero by registering the movement of the fetus and its environment (mother). That the Vestibular Nerves myelinate first indicates that they perform the first essential function for survival—before the need for registering touch to the head, taste, smell, hearing and vision.

This indicates that we learn first through the perception of movement. Not only is movement a perception, but as the first perception of learning, it plays an important role in establishing the baseline for our concept or process of perceiving. This original process of perception then becomes incorporated into the development of the other perceptions.

THE VESTIBULAR SYSTEM

The registering of movement is not only the responsibility of the Vestibular Nerves. It is sensed through special receptors located throughout the body. The whole movement or vestibular system is composed of the inner ear, vision, proprioceptive, kinesthetic, and touch receptors located throughout the body, and interoceptors in the organs. To these I would add the movement of each cell. More specifically:
• The vestibular mechanism located in the inner ear receives information from the proprioceptors, interoceptors and kinesthetic receptors throughout the body and from gravity, space and time.
• The proprioceptors and kinesthetic receptors in the bones, joints, ligaments, muscles and fascia, tell us where each part is in relation to the other parts, where each part is in space, and their quality of rest and activity.
• The interoceptors in the organs, glands, blood vessels and nerves tell us where the organs, glands, vessels and nerves are and their state of rest and activity.
• Each cell experiences its own life process—it breathes, ingests, digests, excretes, moves and receives feedback from itself and from all the other cells of the body.
Active Perception—
The movement and perception must be aligned here because they are in physical danger.
THE INNER EAR

The inner ear registers where we are in relationship to the Earth via the magnetic attraction of the pull of gravity. In the inner ear there are little stones called otoliths and little hairs called cilia. The stones fall toward gravity and stimulate the cilia. This stimulation of the cilia by the otoliths tells us where our head is in relationship to the earth. Vision, the contact of our skin on the supporting surface, and gravity receptors throughout the body which register our mass, or our weight, also provide us with information about our interaction with the earth.

The inner ear also plays an important role in establishing a basic postural tone throughout the body. Postural tone is the readiness of the muscles to respond. I feel that our basic postural tone is an indication of how we are relating to the earth via the pull of gravity. It is reflected in the quality of our movement. Low tone indicates that we are having difficulty meeting the force of the earth’s pull; high tone indicates that we are over-reacting to the pull of gravity; an even, balanced tone indicates that we have a comfortable relationship or balance with the earth’s force.

Helping us to establish our relationship to space is another function of the vestibular mechanism in the inner ear. It receives information, via the brain, from the other movement receptors (proprioceptors, interoceptors, and kinesthetic receptors) throughout the body telling us where we are in space and how we are moving through it.

Changes in time are also registered in the inner ear. The semi-circular canals register changes in velocity (acceleration and deceleration) as the head moves through space. Temporal changes are also registered by kinesthetic receptors throughout the body.

In utero, the baby perceives the movement of its mother as inseparable from itself. Both in and out of the uterus, we are registering the movement of the Earth and the universe, but until we are born from them or separated from them, we cannot perceive their movement as separate from our own.

PRECONCEIVED EXPECTATIONS and PRE-MOTOR FOCUSING *

Our perception of movement, i.e., our interpretation of movement, is dependent upon all of our previous experiences of movement, as it is for every other sense. We develop preconceived expectations based upon how we have perceived similar information in our past experiences. These expectations then precede new sensory input.

Thus, we can add the first of the additional phases to our sensory-motor loop:

Preconceived expectations — Sensory input — Perceptual interpretation — Motor-planning — Motor response — Sensory feedback — Perceptual interpretation

The second phase that I feel is essential in expanding our potential for choice is based upon our ability to direct or focus our sense organs. This is a motor act. It is the motor component of perception. It is demonstrated by a dog directing its ears toward incoming sound, by the way the hairs of our skin move to pick up sensation, and by the way we focus our eyes in order to see. It is the motor ability to choose which aspects of incoming stimuli we will absorb or attend to.

Another example would be if you were riding in a car with someone. If you are the driver, you have more of a need to see, so your pre-motor focus is more involved, than if you are the passenger. You are looking at the same information, but the driver is having more motivation, concentration, and sense of responsibility than the passenger.

In ourselves we can see this pre-motor focusing as motivation, desire, attention, and discriminating awareness. We can see the absence or repression of it in boredom, resistance, and difficulties in learning.

So, the sensory-motor loop then becomes:

Preconceived expectations — Pre-motor focusing — Sensory input — Perceptual interpretation — Motor-planning — Motor response — Sensory feedback — Perceptual interpretation

Why not call this pre-focusing phase, pre-sensory or sensory planning? Because it is a motor act. It is the active decision of what stimulation you will take in. However, this "active decision" is usually unconscious, based upon previous experience. For instance, there was a point in my life when I was so fatigued that I realized that I had lost all desire except to sleep and to survive in order to nurture my children into adulthood. I realized that in order to do this, I had no choice except to focus on what I needed, which was to sleep and sleep and sleep. Eventually as I continued to focus on rest, I recuperated and rejoiced as other desires began to emerge and exert their presence. I knew I was surviving.

An example of conscious pre-motor focusing is to first gaze around the room randomly. Do it. Now, pay special notice to the color red. Now yellow. Now blue. Green. Purple. Orange. And so forth. How did your perception of the room change as you consciously pre-motor focused?

This pre-motor phase differs from motor planning and motor response in that it directs the organization of the sensory input as far as how you focus. The later motor planning phase is how you will organize your response to what you have observed, and the motor response is what you actually do about it.

THE DIALOGUE BETWEEN MOVEMENT AND TOUCH

I would like to look at another fundamental relationship underlying the development of perception—the dialogue between movement and touch.
In utero, as the fetus moves, it receives immediate tactile feedback from itself and from its environment—its body parts rub against each other, against the wall of the uterus, and against the amniotic fluid. As the fetus moves, it pushes against its mother’s organs, which in turn push back against the fetus. When its mother moves, there are changes in the fluid and organ pressures against the fetus’s skin.

It is interesting to me that the Vestibular Nerves, which perceive and help organize movement throughout the body, are the first of the cranial nerves to myelinate. The second group of cranial nerves to myelinate are those involving the processing of sensory and motor control in and around the mouth, which is necessary for breathing, sucking, and swallowing—the first survival functions after birth.

It is equally interesting that of the spinal nerves, the motor nerves myelinate before the sensory nerves. When I first read that the motor nerves myelinated first, it didn’t make sense to me because it seemed to contradict all the sensory training I had done in my movement and dance training with Andre Bernard, Barbara Clark, and Erick Hawkins. They had taught me to reorganize my motor response by altering my sensory perception. However, I finally recognized that one needs to move before one can have feedback about that movement.

When I work with babies and young children who have neurological dysfunctions and are delayed in their development, I am impressed that along with facilitating their “sense of movement,” one of the major keys to re-patterning their nervous systems lies in stimulating their tactile receptivity.

If they do not utilize a body part in normal movement and I stimulate that area with light touch or brushing with a soft brush, they begin to initiate movement with that body part. For example, if the baby cannot turn its head to follow a toy with its eyes or to roll over, and I stimulate its mouth (inside and/or outside) with the toy, it will usually soon turn its head and follow the toy and roll onto its side.

Another example is a baby who cannot reach for a toy, cannot open its hand and grasp the toy. By brushing the baby’s hand with a brush and/or the toy (I have a little bright red rag doll with lots of yarn hair that is wonderful for this) the child will usually soon be able to reach and grasp the toy and play with it.

A third example is a baby who keeps its toes curled under and cannot bear its weight on an open foot. Brushing the top of the foot and usually up the outside of the foreleg, can provide the child with the tactile information it needs to open its toes and to place its foot on the ground in an open position.

In the above examples, touch plays a major role in the opening of the child to itself. However, it is not only a mechanical stimulation, but one aspect of open communication between two people in a playful dialogue within a totally receptive, perceptive environment. In this context, the tactile stimulation organizes the baby’s attention so that it is able to exercise intention.

There are numerous reasons why a baby may have neurological dysfunctions. They can be due to genetic differences, in-utero problems, birth trauma, trauma after birth, nutritional difficulties, and environmental/social factors. One in-utero scenario may be that there was a problem in the fetus’s ability to move, which diminished its experience of tactile stimulation, which then limited its skin’s ability to let its body part know that it exists and where it is, which prevents the body part from expressing itself (through movement). It is interesting that whatever the initial cause, facilitating the child’s experience and organization of touch and movement is fundamental in unraveling their inefficient nervous pathways and establishing a firm foundation for their optimum development through the other senses. Because perception is a cyclic process, it can be entered anywhere in the cycle. Thus, one has many options for facilitating change.

Words remain always an outside viewpoint when describing experience. I do not mean to underestimate the importance of the other senses of taste, smell, hearing, and vision. They are essential and wonderful! I only wish to awaken people—society—to the key role that movement and touch play in the dynamic development of the experience of perception itself, regardless of the particular sense organ being stimulated.

THE INTERWEAVING OF THE PHASES

The experience of movement and touch are basic to our discovering who we are and who is other and how we interact this life together. Sensing is not just passively being stimulated; perceiving is not just passively receiving input; motor is not just responding directly to stimulation. There’s both perceptual activity in the motor activity and motor activity in the reception of input, in perception.

Learning is the opening of ourselves to the experience of life. The opening is a motor act; the experience is interaction between sensory and motor happenings. When the experience of movement is integrated into our education, our perception of ourselves and the world changes.

Contact improvisation is a clear example of this opening up of one’s perception and thereby one’s options (pre-motor focus, sensitivity (sensory), awareness (perception), ability to respond (motor), and to feel successful in your self and in your communication with your partner (perception).

Contact embodies, as a technique, the interweaving of these phases. You change your focus, you receive new information, you discover new possibilities, you open up to the immediate happening, you . . . dance. You touch and are touched—with the head, back, feet. You’re moving; your environment is moving. One minute you’re focusing on weight, then on space, on touch, on pressure, on your movement, your partner’s movement, on falling, on being supported...
Between Bodies: using Experience Modeling to Create Gestural Protocols for Physiological Data Transfer

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ABSTRACT
In this paper, we describe the use of experience modeling to create gestural protocols for physiological data transfer. This design method has been applied to the development of a wearable computing public art installation called whisper.

A series of user-experience workshops were designed with the goal of developing an interaction model for the public installation. These workshops modeled intimacy, social navigation and playful exchange, using performance methods to create gestural protocols.

Workshop participants generated movement vocabularies by negotiating permission and control of their own physiological data. Gesture was utilized as an expressive indicator of intentionality, extension of body image, permission, control, exchange and play.

We illustrate through video, gestural analysis, and experimental feedback, how the workshops provided an experience model for the interaction, wearable garment design, and body-to-body network protocol used in the public art installation, and how performance methodologies can contribute to the area of interaction design.

Author Keywords
gestural protocols, performance methods, choreography, wearable computing, intentionality, improvisation, first person methodologies, physiological computing, play, experience prototyping, public art, informance design, bodystorming, somatics, experience design, social navigation

ACM Classification Keywords
H.5.2. User Interfaces, User-Centered Design, Prototyping

1. INTRODUCTION
The title Between Bodies is a metaphor that provides our framework for experience modeling. Our work in designing and testing experience models borrows methodology from the performance practices of Theater [4], Dance [3], and the field of Somatics [12], expanding work in the area of user-centered design, experience design, and participatory design. Our premise is that performance, as a practice-based research domain, contains a longstanding history of constructing experience models. Many participatory design perspectives omit the bodily experiences of participants. Performance-based experience methodologies can contribute to exploring our bodies’ physical responses in the growing area of interface design for ubiquitous, wearable and affective computing. We explore embodied cognition and interaction as a reflective process that is simultaneously inter-body and intra-body. This research provides a case-study for a model of designing embodied interaction.

1.1 Artistic Aim
One of the major themes of the installation whisper is the notion of ‘paying attention’ to one’s self, and using this sense of self to connect to, and exchange with another. This requires an ability to transfer this ‘sense of self’ to another person. Designing expressive interactions that afford intimacy, privacy, affect as well as connection are the goals of interaction. How can a system create a willingness, a trust, the ‘suspension of disbelief’ needed to enter into an exchange of information that is otherwise private and ‘unknown’? To explore these questions of access to experience we turned to performance methodologies. For example, techniques for extending our bodily awareness through attention to breath and movement are common to performance methodologies found in theatre and dance. Techniques in these domains build both intra-body and inter-body knowledge by focusing on our perception of our own physical data. This includes having access to, and agency over our own breathing, our own heart, our own thoughts, and our own body state. In the installation this is afforded through the use of measuring physiological data as a representation of one’s self, and in effecting how this data is displayed, exchanged, and shared.

1.2 The Outcome: A Wearable Public Installation
We developed an interaction model for the public art installation through a series of experience workshops outlined in this paper. whisper is a real-time interactive public art piece, based on small wearable physiological sensors, micro-controllers, and wireless network transmission, embedded in evocative and playful garments worn by the participants. whisper is an acronym for wearable, handheld, intimate, sensory, physiological, expressive, response system. Focusing on body state represented through participants’ breath and heart rate, whisper aims to monitor physical data patterns of the body, mapping heart and breath physiological data onto linked and networked devices worn within a specially designed garment. whisper collects breath and heart rate data from the bodies of participants, and through visualisation and sonification techniques, enables participants to interact, interconnect, and interpret their own and other participants internal data in playful and responsive ways.
The workshops were modeled using a range of performance examples are described throughout the paper.

The wearable installation is the outcome and testing ground for an experience modeling methodology described here. *whisper* has been exhibited at DEAF03, the Dutch Electronic Arts Festival, in the public lobby of the Schouwburg Theatre, in Rotterdam in February and March 2003, at Future Physical’s Respond festival, in Cambridge, UK in March and April 2003, and at the e-culture fair at the Amsterdam Paradiso in October 2003. Up to six participants are able to listen to and affect their own body-state represented by their physiological data (breath and heart-rate). They are also able to connect to and exchange their physiological data with other participants in the interaction space through gestural interactions which enable connecting, listening, exchanging, giving and receiving.

2. BACKGROUND

During our design workshops, gesture was utilized as an expressive indicator of intentionality and body state. We modeled our workshop methods on performance techniques that provide a link between embodied interaction, activity theory, user-centered and participatory design, and situated cognition. Within HCI, gesture/movement design analysis is an under-theorized area, and a need exists to explore richer methods to create gestural interaction. Our work attempts to bridge this gap, and specific examples are described throughout the paper.

2.1 Workshopping Experience through Gesture

The workshops were modeled using a range of performance techniques such as improvisation, props, phantom partners, prosthetic devices, ritual space, and placebo objects. We used attention modeling that incorporated listening, sending attention and touching; imagining and visualization; focus on somatic attributes such as breath, heartbeat, stillness, slow motion movement; journaling using hand-writing and drawing; social navigation using gesture and touch to express permission, trust, exchange, and feeling; and costumes and props to express physical extension, connection and group identity. The goal of the workshops was to model experience that could be replicated, re-enacted, and re-played in the context of a public art installation using wearable computing technology. The design goal of the public art space was that it could be simultaneously intimate, playful, and social, while developing a level of awareness of our selves.

We illustrate our process through video, gestural analysis, and experimental feedback. Gestural protocols created and imagined by the workshop participants during playful engagement became the basis for: body to body network protocol; the wearable garment design, including the selection of connection points, placement of wearable computers, sensors, wiring paths, and visual display systems; and for the mechanisms of gestural connection, intention and data sharing that was used in the public art installation.

2.2 Performance Methodologies as Experience Models

There is a common ground that exists between the domains of HCI and performance practice. We refer to this shared ground as first person methodologies: techniques and protocols that articulate models of experience. We posit that it is precisely the differing frames of reference between the domains that can reveal an under-theorized area of practice. For example, the need to have models of interaction and the experience of the ‘user’/‘performer’ can be seen to be one such shared starting point that is framed through differing methodological strategies. How are these models of interaction conceived, constructed, and integrated within a design process? What are the underlying assumptions that differ between these domains?

We explore interaction as a space of lived experience and enactment, as something that is simultaneously between bodies and within-bodies. Specifically, human-computer interaction, as it is defined by human experience in which action and meaning are inseparable. We explore human interaction as a model for developing relational human computer interaction systems.

One of our contributions to this shared domain of developing models of experience, is that in our work, the ‘bridge’ is being built from the side of performance practices, rather than from the side of HCI. This brings with it new vocabularies, techniques, with an emphasis on building knowledge within the experience of the body, an area well defined within Performance and Somatics.

Dourish [9] lays a strong argument for a foundation in HCI that validates the notion of an embodied interaction. The need to augment abstract reasoning and objective meaning with practical action and everyday experience is central to this approach. Dourish notes that his contribution is foundational, rather than methodological, which opens opportunities for methodological modeling and testing as a critical next step in the development of this area.

Suchman’s [28] ethnographic research, which views all activity as situated and embodied, and her interest in purposeful, intentional activity, alongside Nardi’s [18] work in constructing a “theory of practice” within HCI based on the development of activity theory and intimacy between human and machine constructed through intense relational concentration, provide strong bridging links to our work.

2.3 Gestural Movement Vocabulary

What are the properties of a gestural movement vocabulary? In Activity Theory, Nardi [18] illustrates the notion of a “function organ” – a transforming bond with an artifact. A photograph depicts a child listening intently to the radio, the expression of intense concentration suggests the creation of a relation between body and object. In dance and theatre the gesture itself can also become a “function organ”, an artifact that creates or enacts a transforming bond between the participant and their own movement. In this way, we think of the gesture *itself* as a function organ: an artifact that creates affordances for interaction.

The design of specific gestures that can become enactors is a notion common to theatre and dance practice. We follow with examples from performance practice that support this notion. Richard Schechner [22] uses the term *Restoration of Behavior*, to describe gesture as “material”. Restored Behavior is organized as sequences of events, scripted actions, or scored movements. He refers to these as strips of behavior, and states that a restored behavior, although “originating from a process, used in the process of rehearsal to make a new process, or performance, the strips of
behavior are not themselves process but things, items, material”.

This concept of gesture as source ‘material’ for designing interaction models is central to our work explicated in this paper.

Augusto Boal [4] in Games for Actors and Non-Actors, states that “bodily movement is a thought, and a thought expresses itself in corporeal form”. Boal’s arsenal of theatre can be used to re-enact, or re-materialize the body state that accesses or indexes that thought, or “thought-unity”. Grotowski refers to an acting score as a script for designing point of contact or connection [23]. In Interaction Design this is the equivalent of interaction schemas, which are navigated in order to construct the instantiation of the interactive experience. Grotowski speaks to the necessity of scripting gestural sequences in order to construct connection schema: “what is an acting score? The acting score is the elements of contact. To take and give the reactions and impulses of contact. If you fix these, then you will have fixed all the context of your associations. Without a fixed score a work of mature art cannot exist” [23].

We suggest using gesture as a “function organ”, as a mechanism that can assist in defining properties for a scripted interaction score. These gestural function organs have the goal of paralleling processes to construct Grotowski’s concept of mature art: works of “mature interaction”.

3. PRIOR WORK IN DESIGNING EXPERIENCE

What do we mean by experience modeling? By bridging domains of performance practice with interaction design and HCI, we are focusing on an area of enacted cognition: the enactment of descriptors, or schemas for movement.

3.1 From Experience To Experience modelling

Previous research in the use of exploring experience/ performance methods within the HCI community has occurred in the domain of user-centered and participatory design [10][14]. This has included: experience prototyping that fosters an ‘empathetic’ and ‘embodiment’ approach to user-centered and scenario-based design [5]; Interval Research’s exploration of infomance: informative performance and bodystorming: physically situated brainstorming, repping: re-enacting everyday people’s performances, and explorations of how Low-tech solutions can create a design environment that focuses on the design question rather than the tools and techniques [6][21]. Salvador and Howells [20] shifted the focus group methods to something they called Focus Troupe: a method of using drama to create common context for new product concept end-user evaluations. Simsarian [26] has explored the use of role-play in extending the richness of the design process. In the Faraway project, Andersen, Jacobs, and Polazzi [1] explored story telling and ‘suspension of disbelief’ within a context of game and play in a design context.

3.2 Building Experience within Performance Practices

In order to provide a context for the techniques we use in our workshops, we introduce an overview of some of the work that has been explored in the performance domain related to constructing models of experience. This discussion is by no means complete, but suggests a range of models that can be borrowed in order to define experience methodologies. For example, Dance Analysis and Somatics specifically construct systematic articulated movement models directly from the experience of the moving body. We are interested in applying these models in our work with interactive systems.

Somatics is a term coined by Thomas Hanna in 1976 [12] to label a field that was beginning to develop mind/body integration disciplines using the body as experienced from within. Somatics can be defined as the experience from within the lived body, and is an example of first-person methodologies. It includes practices such as Laban Effort-Shape Analysis, Feldenkrais and Alexander technique. From the Somatics perspective, knowledge is constructed through the experience of the body [12][13], and requires that experience be directed or focused through awareness. Somatics differentiates between conditioning and learning. In these terms, experience alone is not a pre-cursor to knowledge acquisition, since experience alone could result merely in conditioning, or in accessing conditioned responses. In Somatics this would be termed “somatic amnesia”. However, when experience is specifically directed through the focus of attention, knowledge acquisition takes place which can be referred to as “somatic learning”, an activity expanding the range of what Hanna [12] terms volitional attention. In our workshops, we specifically used methods to direct and access attention, (what we termed earlier as attention modeling). Attention modeling enables us to create affordances to access specific body states that increase awareness. In our workshops, we were interested in creating repeatable, enactable, embodied states that could be used in interaction design. While Csikszentmihalyi [7] suggests that human experience operates within a limited field of attention, other movement systems within Somatics consider attention to be a generative attribute of awareness that can be augmented, increased through a process of somatic learning [12], or conversely, limited or atrophied through a process of somatic amnesia.

Rudolf Laban’s movement analysis systems [15][19], and the work of other researchers such as Bartenieff [2] and Blom and Chaplin [3], are examples of physical methods to create gestural typologies based in experiential practices of dance [24][25]. These systems model a range of qualities and modes of movement. Laban and Bartenieff’s work creates a systematic description of qualitative change in movement. Blom and Chaplin create a set of exercises that explore choreographic techniques for movement generation. We use aspects of these typologies for gestural mapping and modeling qualitative movement characteristics such as intentionality, interest, attention and body state. They present experience models for the classification of aspects of movement, and define a means to approach gestural and choreographic protocols.

Participatory design, experience design, performance, theater, dance and somatics share a common focus in modeling or representing human experience. These domains also share the ability to articulate and explore engaging experience through movement, emotional response, sensorial qualities, and temporal/dynamic qualities of experience and of movement.

4. EXPERIENCE WORKSHOP DESIGN

To develop an interaction model for our installation, a series of workshops were designed. The workshops modeled participant experience of non-verbal expressive gesture that shared and communicated physiological data. At the beginning of our workshop process we included four categories of physiological data: breath, heart rate, galvanic skin response (GSR) and brain signals. The workshop exploration utilized choreographic methodologies in order to create gestural movement vocabularies.
In the context of this work, workshops are a formal, scripted experience in which a specific physical experiential concept is explored, tested and documented for the purpose of developing an interaction model. The term workshop is borrowed from its performance context, where a script or form is ‘acted out’, ‘acted through’, and explored with the intention of testing, developing and iterating a theatrical model. This theatrical model also becomes the foundation for the interaction | technological model: the model that provides a basis for the development of the interaction through the technology. As with the theatrical model, the interaction | technological model, includes a set of experience concepts such as intention, gesture, direction of focus or attention, relationship, rhythm, body-state, and use of, and attitude to space. This model creates a formal container for experience that includes a physical as well as technological description, and is a process that enables an evaluation, assessment and analysis of the formal relational elements that operate successfully or unsuccessfully in the construction of that experience.

4.1 Workshop Design: First come First Play
We made use of a series of workshops in order to investigate and prototype the representation of experience for the forthcoming installation. The workshops were designed in the following manner: Each workshop had up to 12 participants with a maximum duration of about 45 minutes. Participants were students and employees at Simon Fraser University and participation in the workshops was assigned on a first come first play basis. Invitations were e-mailed to the University School community each week, with a simple subject line such as “invitation to listen”, where <listen> is the title of the workshop. Contextual or conceptual information was purposefully left out of the e-mail exchange and workshop formats, creating an affective, metaphorical, yet ambiguous framework [11] for the invitations. The workshops took place once a week over 5 weeks. Each workshop was divided into two components or exercises that encompassed an overall theme represented by the name of the workshop. Each exercise was based on clearly stated tasks represented by the theme. For example, the exercises in the <listen> workshop were listen inside and listen outside.

The facilitation of the workshop followed a designed script, and attention was paid to using everyday non-specialized language. The themes/names of the workshops were listen, between, mutate, extend and phase. After each segment of a workshop the participant was asked to write their experiences on a single card which included two to three simple open ended questions. Participants were given time to write, note or draw their experiences in long-hand written “journaling” form. The workshops were conducted in a ‘blank’ circular space delineated with ‘theater black’ curtains. The workshops were videotaped and photographed throughout.

In the following section we describe a selection of workshop experiences.

4.1.1. workshop <listen>
themes: listening/awareness/body-data/self to self
One of the major themes of whisper is the notion of ‘paying attention’ to one’s self. As the installation centers on measuring physiological data as a representation of one’s own self, data that we are not normally aware of in our day to day life, the first series of experiences and experience questions relate to how we perceive and deal with shifting attention to our own data, to having access to, and agency over our own heart beat, our own breathing, our own thoughts, our own body.

This experience was initially prototyped in the workshop exercise called <listen>. The participants were asked to walk around until they found a place for themselves in the space. They were asked not to speak. A facilitator then gave each of them a pair of earplugs and they were then left alone with themselves with no further instructions for about 15 minutes. At the end the earplugs were collected and each participant was handed a card (see fig. 3). The card asked the questions: What did you hear? How did you hear? What did it feel like?

In the space of experience, this is the simplest of experiments. By depriving the body of its external hearing we become aware of the internal sound that is otherwise drowned out by the louder external sounds. We are removed from our own cars, but not from our hearing. In performance, artists like Pauline Oliveros and Augusto Boal have created practices such as “deep listening”, and “listening to what we hear”, which probe and access these very same questions of experience. The responses to the question on the cards: What did you hear? focus on this. Responses indicated the participants’ discovery of the internal soundscape.

‘Heartbeat; earplugs as they settle, breath, slapping sounds from others in the room; humming noise; myself; contact with my own body’
This seems to trigger strong emotions ranging from slight unease to feelings of fear or elation in the answers to the question: What did it feel like?

'I felt self-consciousness about all the sound that body makes; it wasn’t sound; it was movement, vibration. I could hear the movement of my body'

'Pain, shifting between past and present; fear / calm'

'Normal, I’m alive; Invigorating - breath going in and out with “normal” rhythm, and changing properties'

Some workshop participants were able to shift their internal awareness to recognize that listening occurs not only through the ears, but also through the bones, the resonant cavities of vibration in the body, that the body is a metaphor for listening, and that, what is heard, is not only sound, but movement, vibration, feeling, and sensation.

4.1.2. workshop <between>

themes: awareness/attention/sending/receiving/self to other

The ability to transfer data to another person and the willingness to enter into an exchange of information that is otherwise private and ‘unknown’ is the other main theme for whisper. In order for such a transfer to work, the participant needs to engage or invite trust not only to the other, but also to the ‘listening’ self.

In order to investigate the invisible transfer of personal data, and the trust of the self, we created a workshop experience we called <between>.

Figure 4. sending and receiving invisible signals

At the beginning of the workshop, the participants were asked to find a space for themselves and begin to move in slow motion, as slowly as possible. They were then left to move very slowly for 10 minutes without speaking.

In Dance practices such as Butoh, this technique is utilized to enable the body to shift its attention to an immersive state in relation to its environment, what Csikszentmihalyi would term ‘flow’, where attention is intensified, and sensory details are sharpened.

The workshop participants were then asked to pair up, with one person selecting the role of the sender, and the other selecting the role of the receiver. The sender was asked to silently create an image for two minutes, and then send the image to the receiver, while the receiver was asked to simply pay attention to ‘listen’ for what image ‘came to mind’. At the end each participant was handed a card with the questions: What did you send? What did you receive?

What did you send? “A stick cat!”

What did you receive? “Not sure, could be a small dog”

4.1.3. workshop <extend>

themes: transfer/sharing/play/self to other

As stated in the previous workshop, transferring private, internal and personal data to another person requires a willingness to enter into a private exchange of information. The participant needs to invite trust with the other, and also engage in a level of agency as to whom, and where, this exchange takes place.

We wanted to continue to investigate these issues of privacy and trust using physical objects that could mediate the interaction through physical gesture. We created a workshop experience we called <extend>, which augmented the invisible data with a non-digital amplification device. The participants were given ordinary medical stethoscopes and a small booklet with ten identical pages. On each page there was space to write or draw and each page had the questions: Where you listening? What did you hear?

'I felt like I was inside myself the pounding amplified my perception of myself, yet my breathing made me feel close’

'My friend stood up and tried to hear my heart, it was hard, I heard my heart, I heard low voice’

4.1.4. workshop <mutate>

themes: permission/control/exchange/touch/islands/snaps

By introducing the stethoscopes we gave access to another type of body data. More importantly, we introduced the possibility of sharing this data with someone else. The design of the stethoscope with a ‘listening’ end and a ‘probing’ end allows for the data to be shared by either probing someone in order to investigate their data, or giving someone the earpiece to offer them a particular sound. The latter gesture of offering inverts the interaction model of probing or surveillance, to an interaction which invites and affords intimacy, trust, and peer connection.

Figure 5. Response Card Sharing Physiological Data

By introducing the stethoscopes we gave access to another type of body data. More importantly, we introduced the possibility of sharing this data with someone else. The design of the stethoscope with a ‘listening’ end and a ‘probing’ end allows for the data to be shared by either probing someone in order to investigate their data, or giving someone the earpiece to offer them a particular sound. The latter gesture of offering inverts the interaction model of probing or surveillance, to an interaction which invites and affords intimacy, trust, and peer connection.

4.1.4. workshop <mutate>

themes: permission/control/exchange/touch/islands/snaps

By introducing the possibilities for sharing we immediately encounter notions of permission, surveillance and thresholds of privacy. The following workshop introduced Galvanic Skin Response [GSR] data, and investigated thresholds of boundary, agency, and control.

In the first exercise of the workshop the participants were given white men’s shirts that were attached by simple sewing [basting] into pairs at various locations such as the seam of the sleeves, the back shoulder seam, and the seam at the cuffs. Each shirt pair set had a unique contact seam; no two pairs were connected identically.
The participants were instructed to put on the shirts and button them up. This is a difficult task that requires the pairs to cooperate, both physically and socially, but it also dictates a close proximity between the participants. A series of movement related tasks followed. As in each workshop experience, following the experience, participants were given cards to fill out. An example of the challenges in allowing this proximity is present in an answer to the question: How did you change?

'I wouldn't have gotten that close/intimate under normal circumstances'

In the second half of the workshop the participants were grouped again in pairs and given primitive boards that measure GSR. The boards were constructed in such a way that one of the participants is wearing the sensors [simple metal points of two fingers] and the other has the output [a red LED] pinned on the shirt and connected to the board with a long wire. As the GSR goes up or down the red light brightens or dims. The participants were also given small booklets asking the question: What did you feel?

'As an observer, a recorder, an instigator, responsible'

Here we see an example of one type of response to this particular sharing situation. The first responder classifies him/her self as the passive observer of the other, but since the output of the GSR is closely related to emotional excitement this observer, also feels involved and responsible. By taking responsibility for the output you also take responsibility for the object of your observation.

'I do not know, Dennis is not showing me my output, I will attempt to limit my input to nil, to avoid detection'

This is an example of another group of responses. The observed party feels exposed by the observer not allowing access to the output data and as a consequence the observed participant will deliberately try and influence the result. In this way the observed party changes the rules of engagement and turns what was a probing of emotional personal data into a game.

The next exercise is investigating this blur, as we asked participants to put on men’s shirts again. This time the shirts were given sticky Velcro patches to apply connection points anywhere they wished. The participants were then encouraged to experiment with moving as each pair of shirts have different possibilities for movement and control. The cards asked the questions: How did you extend yourself? How did you move?

How did you move?: ‘Held hands with someone other than my husband; became silly; enjoyed the unusual and unknown; became aware of another’s movement’

How did you move?: ‘I found myself thinking of our ’body’ as a complete unit - it just had this other piece I wasn’t controlling; the attached arm felt very unusual once I got complete control back’

How did you move?: ‘I was no longer just myself. I had to extend myself to become a part of a whole; as a whole we had to work together; when we failed it was almost disappointing because we were apart’

Here we see several examples of body extension. It is interesting to see the apparent disappointment when the appropriated body gets separated or the combined body fails to complete a movement task.

4.2. Workshop Results: Experience to Gestural Protocol

During our design workshops, gesture was utilized as an expressive indicator of intentionality, body state, extension of body image, permission, control, exchange and play. The workshops were modeled using a broad range of performance techniques. Improvisation was used in all five workshops, improvising both movement and stillness. Stethoscopes, ear-plugs, blindfolds, heart monitors, GSR sensors were used as props. Men’s White Shirts became phantom partners, prosthetic devices and placebo objects. The simple ‘black box’ curtain became a ritual space. We modeled the use of physical attention that incorporated listening, ‘sending’ invisible messages, and touching to connect one’s self to another. We used imagining and visualization to explore movement vocabulary. We focused on somatic attributes such as breath, stillness, and slow motion movement. Journaling in both hand-writing and drawing was used as a method of documenting, archiving and expressing. The workshop participants integrated social navigation using gesture to express permission, trust, exchange, and feeling. And the white shirts as costumes along with various props, modeled and expressed physical extension, connection and group identity. The design of the stethoscope with a ‘listening’ end and a ‘probing’ end allowed some participants to invert the normalized medical surveillance ‘probing’ model of listening in favour of giving someone their earpiece to offer them a particular sound.

The workshops contained a broad range of experience results that enabled us to construct gestural protocols within the installation. We continually came back to the main theme found within the workshops, and the artistic aim of the installation: that ‘paying attention’ to one’s self enables a re-direction of attention with a greater access to optimal experience [7]. The workshops responses illustrated that the body can become a metaphor for listening, and that what is heard, is not only sound, but movement, vibration, feeling, sensation, and the self. We discovered that some workshop participants were able to shift their internal awareness to recognize that listening occurs not only through the ears, but also through the bones, the resonant cavities of vibration in the body.
In Theatre and Dance practices such as Noh and Butoh, the slow motion technique used in the <between> workshop enables the body to shift its attention to an immersive state in relation to its environment, where attention is intensified, and sensory details are sharpened.

Augusto Boal [4] terms these types of experiential exercise de-specialization. He states that in our every day lives “the senses suffer. And we start to feel very little of what we touch, to listen to very little of what we hear, and to see very little of what we look at. We feel, listen and see according to our specialty. The adaptation is [both] atrophy and hypertrophy. In order for the body to be able to send out and receive all possible messages, it has to be re-harmonized [through] exercises and games that focus on de-specialization.” Our workshop series are related in form and function to Boal’s arsenal of theater series of listening to what we hear, exercises of the 4th series: rhythm of respiration, and 5th series: internal rhythms.

The workshops met their goal of modeling experience that could be replicated, re-enacted, and re-played in the context of a public art installation using wearable computing technology, where the public art space was simultaneously intimate, playful, and social. As a consequence we selected a subset of successful gestural interactions to be specifically modeled within the installation.

5. DESIGN CONSEQUENCES
The workshops were the basis of the concept design, interaction model, and development of the whisper installation. The workshops made it possible to probe and investigate the underlying interaction issues early on in the hardware and software development process. A significant design outcome from this process was the importance for each body to physically control access to their privacy, and allow shared play of their own body data. This was enacted in the installation by the Gestural Protocols discovered during the workshops, where costumes or white shirts expressed physical connection and extension of the body through ‘sticky’ connection points.

In the workshops these connections were ‘sewn’ together, or explored through Velcro fabric swatches that enables participants to play with connection placement. These connection points were engaged through ‘feel’ or ‘touch’ rather than through a visual symbol or natural language interface.

As a consequence of this workshop exploration we designed a tactile interface to the wearable garment. This consists of a set of wired clothing snaps attached to the right hand fingers of the participant and a series of tactile ‘islands’ placed in various positions on the wearable device. These islands are small id chips wired up to matching sets of snaps. By touching the snaps of an island with the finger-snaps the participant can choose and mix between the different sets of body data coming from his or her own body. In order to access data you have to negotiate physical and social interaction of touching someone.

The islands are made from different textures to allow the participants to navigate the data through touch and feel.

6. CONCLUSIONS
Our work in designing and testing experience models has illustrated that we can augment experience design with first person performance methodologies found in Theatre, Dance and Somatics. The differing frames of reference between the domains of HCI and performance practice reveal an under-theorized area of practice, which can be explored through experience modeling. We have explored embodied interaction as a reflective process that is simultaneously inter-body and intra-body. In addition, we have provided a case-study for a model of designing embodied interaction. We have applied the use of gesture as a “function organ” [18], as a mechanism that can assist in defining properties for an interaction score that Grotowski [23] describes as scripts, or points of contact. The experience with the installation illustrates that participants can learn to shift their own threshold of attention, awareness and body-state through the interaction affordances created within the gestures and embedded within the garment. They participate in “becoming expert” users of their own physiological data, and in playfully engaging with an emerging co-operative and physically and emotionally negotiated body state and collective system state. Social navigation is created through...
the participants’ perceived internal body data flow [through the fingers, or connection snaps] and represented through the actual data flow [through the server]. As such the installation is also its own experience workshop, and is a starting point to continue to explore methodologies of experience modelling.

7. FUTURE WORK
As an installation, whisper was an initial exploration of modeling through gestural protocols that led to the design of an interaction language facilitated by wearable garments. The whisper hardware remained relatively low level due to bandwidth and memory constraints, physiological data patterns were explored directly through server-side visualization, without the development of context aware intelligent devices. Mapping more complex data relationships to body state and intention were not explored or modeled in this work. whisper illustrated that participants could become playfully engaged even in simple feedback loops of “attending to” their heart rate and breath, and exploring or modeled in this work. whisper illustrated that participants could become playfully engaged even in simple feedback loops of “attending to” their heart rate and breath, and sharing that data with other in the space. whisper also pointed to next steps in research: exploring mapping and ‘meaning’ in data sharing that data with other in the space.

Perhaps most importantly, we are interested in continuing explore workshops that model experience by bridging first person methodologies used in performance practice with those of interaction design.

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Believing Is Not Seeing

Ninety-nine percent of the game is half mental.
—YOGI BERRA

WHEN MY SON, Jared, was nine years old he joined the Little League. It was not long into the season before he came home from practice one day crying in frustration.

“What’s wrong?” I asked.

“I struck out every time at bat.”

“Let’s go to the field tomorrow after school. I’ll throw and watch you hit. Maybe I can help,” I offered.

“What do you know about batting?” he challenged.

“You might be surprised,” I said, hoping to keep the conversation open.

Jared responded with a roll of his eyes and a smirk, letting me know how doubtful he was about his mother being of any use to him in this department, but he nodded his head and silently agreed to give me a try.

On the field the next day, Jared stood in position by the plate as I stood on the mound. I threw the ball and watched in dismay. Jared’s neck muscles tensed, pulling his head back and down into his neck. His shoulders squeezed together and his hands gripped the bat. His knees pressed together as his leg muscles clenched and
his body crouched toward the ground. By the time the ball reached
the plate he was a study in tension. Channeling all his energy into
his arms, he swung his bat with furious intensity and missed the ball
completely.

Feeling a mixture of concern and relief, I knew I didn’t have to
be Babe Ruth or Sherlock Holmes to discern the source of his
problem.

“Jared,” I said, “you need to keep your eyes on the ball.”

“I am!” he threw back at me.

“No, you really aren’t watching the ball,” I repeated.

“I am, too!” he insisted, his voice rising.

How to help? Telling Jared that he was not keeping his eyes on
the ball was not going to do it. He firmly believed this was exactly
what he was doing. Disagreeing with him was not going to change
his belief. Shifting my approach, I asked what advice his coach had
given him.

“Swing hard and hit a home run,” he answered.

These were end-gaining instructions if ever there were any. Jared
was entirely absorbed in thinking about his goal of hitting a home
run and had no patience for thinking about the best way to do it. I
had to find a way to get him out of his goal-oriented mind-set and
to open his mind to the idea that he needed to learn to watch the
ball. I knew if he did not give up trying so hard to hit a home run,
he would never get to first base. But how to explain inhibiting to a
nine-year-old, convince him not to think about hitting home runs,
and to relinquish his belief long enough to teach him to see the ball?

“Jared, let’s do this some more. I’ll throw and you hit. Let’s see
what happens.”

Jared stood at the plate, arms up, bat high over his shoulder. He
looked pretty good. As soon as I began to throw, however, his body
changed. All the malcoordinating tension came rushing back. The
ball was a stimulus to which he reacted in an instant, triggering his
belief that he had to swing hard to hit a home run. Was there a way
to trick him into thinking differently, just long enough to give him
a new experience of batting? If I could do that much he might begin
to shift his belief and learn to see the ball. I decided to try some-
thing radical.

“Jared,” I said, “Let’s try something different. It’s very simple. Stand
at the plate and hold the bat the way you usually do. I’m going to
throw the ball, but I don’t want you to move your bat. Leave it where it is. Tell yourself not to swing. All I want you to do is watch the ball as it moves toward you. Keep watching the ball as it approaches you, as it crosses the plate, and even as it passes by you. See it the entire time it’s moving. You don’t have to do anything else. Got it?”

“Okay.” he answered. In a single word Jared’s voice expressed a mound of doubt. I ignored him and pitched. After the ball passed by him, I asked if he’d seen it the entire time that it was in the air.

“I think so,” he answered.

“Let’s try it again.”

I pitched. “What about this time? Did you see the ball the entire time it was moving?”

“That’s weird.”

“What’s weird?”

“I saw the ball as it was coming toward me, but when it was about three feet in front of me it sort of disappeared. Then I saw it again after it passed by me. That’s really weird. How’d that happen?”

While Jared was feeling puzzled, I was feeling hopeful. If he could perceive that he had stopped seeing the ball, we had something I could work with—an experience that might cause him to change his belief.

“That’s great. You’re starting to know what it means to see the ball. You have to see it clearly during the entire time that it’s traveling toward you. When it sort of disappears like that, it means you’ve stopped seeing it. When you tell me you’re not sure if you saw the ball that means you didn’t really see it. Want to try this again?”

Jared nodded. He stood in position, engaged now in the challenge of watching the ball and noticing when it mysteriously disappeared from view. I threw the ball and watched carefully. Even from my pitcher’s distance it was clear, from the movement of his head, when he stopped seeing the ball. When he was seeing it, his head turned smoothly and evenly. When he lost sight of it, his head stopped for just a split second, making the overall movement appear less smooth.

“I stopped seeing it again, Mom.” Jared announced. “I lost it again. This time I lost it just as the ball was almost in front of me.”

“That’s great. You’re learning to see the ball and you’re learning to recognize when you’ve stopped seeing it. This is what you want
to practice. It doesn’t happen automatically, you have to learn it. Let’s keep doing this for a while.”

I threw. Jared watched. I threw some more. Jared kept watching. His concentration had shifted and he was focused keenly on seeing the ball. With each pitch he reported more success at seeing the ball the entire time that it moved toward him. After about fifteen minutes he was consistently seeing the ball through its entire arc of travel. More important, he knew when he’d stopped seeing it—even for just a split second—and was often able to find it again.

In this short period Jared had changed into an eager student. By removing the act of swinging his bat and the accompanying frustration of not being able to hit, he could put his mind on his task. The activity was teaching him, as no amount of arguing possibly could, that he had not been doing what he believed he was doing. After a while he was reporting consistent success.

“What’s next?” he asked with enthusiasm. My son was eagerly awaiting my next instruction, while I tried to figure out what that was. What could be an intermediate step between not swinging the bat and swinging it hard to hit a home run?

“Okay,” I said after some thought, “here’s the next step. This time keep watching the ball. Then let your bat move until the ball is right in front of you, but don’t follow through with your swing. I want you to stop your swing when the ball is right in front of you. If you keep your mind on watching the ball, then you should see the ball and the bat make contact. See the ball and the bat touch, but don’t swing the bat any farther. Got it?”

“Okay.”

Jared stood in batting position as I threw. I watched as the old tension rose again in his body. It seemed he could not help himself. With permission to move his bat, Jared’s old thinking returned—swing hard. He tensed himself in his usual way, did not stop the bat as I had instructed, and definitely did not keep his eyes on the ball. He missed it completely. But he looked up at me immediately afterward and said, “I didn’t keep my eyes on the ball, Mom. I lost it.”

“That’s great, Jared. You knew that you stopped seeing it. What were you thinking about, could you tell?”

“I was thinking about hitting a home run.”

“Aha! So while you were thinking about hitting a home run, what weren’t you thinking?”
"I didn’t keep thinking about seeing the ball."

"You’ve got it. Then your body did just what you told it to do. You thought about trying to hit a home run, so your body became tense. Since you were thinking about hitting hard, you stopped thinking about seeing. I know it’s difficult to believe, but if you can stop thinking about trying to hit a home run and put your mind instead on seeing the ball, the chances are much better that you’ll actually hit a home run. Let’s go back to the first step and practice watching the ball without moving the bat."

I pitched as Jared held his bat over his shoulder and watched. We practiced until he was seeing the ball throughout its entire arc of travel. Then we moved on to the next step of seeing the bat make contact with the ball in front of him. Again Jared met with failure. After several more misses he threw his bat on the ground in frustration and sat down in the dirt.

"Jared, what were you thinking about?"

"I was thinking about when to swing my bat so I could see it touch the ball like you asked," he answered, exasperated.

"But that’s not what I asked you to do."

"What do you mean?"

"I didn’t ask you to think about swinging your bat, I asked you to think about watching the ball and then to allow your bat to move to meet it."

"What’s the difference?"

"That’s a good question. It’s a crucial difference. When I threw the ball, you shifted your thinking and focused your mind on your arms and deciding when to swing. But when you did that, you forgot to keep seeing the ball."

"If I’m not supposed to focus on my arms and think about swinging my bat, how am I going to know when to swing?" he demanded. "I have to decide to swing my bat!" Jared’s voice was rising. I left the mound and walked over to him. In as calm a voice as I could muster I said, "Jared, I know you don’t believe me yet, but the swing will do itself. Really it will. Remember the first step, when I told you not to swing your bat and all you had to do was keep watching the ball?"

"Yeah."

"Since you didn’t have to swing the bat, you didn’t think about it, right?"
“Yeah.”

“That’s what you want to keep doing even when you swing your bat. When you think about your bat, you change how you’re thinking about seeing the ball. Instead, you want to allow your arms to move the bat without paying so much attention to them. You’ve learned to really focus your mind on feeling your muscles working as you move, and feeling your arms swinging your bat. But that distracts you from what you want to be thinking. You want to learn to keep your mind on watching the ball.” As I spoke, I could not ignore Jared’s skeptical expression.

“I know this sounds pretty strange,” I added.

“You bet it does.”

“Jared, just try it. What have you got to lose? Prove me wrong. But prove me wrong by trying it, okay?”

“I can’t believe what you’re telling me, Mom. You want me to tell myself not to swing the bat, but you want me to swing the bat and let it touch the ball? That’s ridiculous.”

“Think of it as magic. If you make up your mind to keep watching the ball, another part of your brain will take in the information about the ball’s speed and direction, process it, and figure out the right moment to swing. You don’t have to do that. In a sense you have a helper inside of you, who will know the right moment to move your arms and swing for you. When you decide to swing by focusing on feeling your arms, you’re getting in the way of your helper. And you quit doing what you want to be doing, which is keeping your mind on seeing the ball. You can’t possibly figure out the right moment to move your bat. Your conscious mind can’t do that. It doesn’t know the right moment to swing. But if you keep your mind on watching the ball, the information will be processed in your brain and another part of your mind will do the swing for you. Trust me. Let’s try it again. You’ll see what I mean in a minute.”

Jared did not answer but he stood up, walked to get his bat, and then stood in position as I walked to the pitcher’s mound.

“Tell yourself not to swing, Jared. You don’t have to worry about the swing. Your helper will do it for you. Just keep seeing the ball.”

I pitched. As I watched it was clear Jared was keeping his mind on the ball. His head turned easily, poised freely on his neck. His shoulders didn’t hunch and his legs didn’t clutch. As the ball neared the plate, his arms began smoothly into motion. There were none
of the previous mannerisms of tensing to get ready to hit. He simply stood, watching the ball, while his arms began moving the bat in a smooth arc. Then the bat and ball made contact in front of him. Jared stopped the bat's forward movement just as I instructed. His timing was perfect.

"I saw it! I actually saw the bat touch the ball, Mom!" he exclaimed.

I felt relieved but aloud I said, "That's what I'm talking about, Jared. You don't have to think about your arms and decide to swing your bat. Let your helper do that for you. Your job is to tell yourself not to swing. And to think of seeing the ball."

We practiced for ten minutes. Occasionally Jared would revert to tensing and trying to swing too hard. Each time he did, he looked up at me afterward and said, "I was thinking about swinging my arms again, Mom. I didn't keep thinking about seeing the ball."

Gradually the activity was making my case for me. Jared was learning to recognize when he reverted to thinking about hitting a home run and deciding to swing his bat. Each time, this caused him to react by getting tense and losing sight of the ball. Among other things, the experience was a powerful lesson for my son in the pitfalls of end-gaining.

"Okay. Now you're seeing the ball and coordinating this with the movement of your arms," I said. "Let's add one more step. This time you can let your bat keep moving. Keep thinking about not swinging and just seeing the ball, but allow your bat to keep moving. Don't stop the swing. Got it?"

"Yeah."

I pitched again. Jared missed. With the new instruction, again he stopped focusing his attention on seeing the ball.

"I didn't see the ball," he quickly confessed, "I didn't keep thinking what you told me to think." We reviewed the first two steps. When he was back on track, we went on to the swing. I pitched and watched as Jared focused, kept his eyes on the ball, and followed its movement. His mind was focused on seeing. Then his arms began to move, his bat traveling smoothly and easily in its arc. There was no undue strain or tension in his body. The ball and bat connected as Jared's arms continued moving. It was a straight, clean drive past me to second base.

"Wow!" Jared said in astonishment. "I wasn't even trying to hit it!"
"That was great, Jared!"

"That's cool!" By now Jared's resistance had vanished. He was absorbed in the learning process and proud of his accomplishment. We continued practicing. My pitches were erratic—too low, too high, outside, inside. Jared kept seeing the ball and making contact. He almost never missed and the majority of his hits were straight drives past me, which indicated not only a new accuracy in seeing the ball but a consistency in timing his swing. Finally we went home to dinner.

As I was saying good night later that evening Jared said, "You know what was really amazing about this batting stuff we did today, Mom?"

"What?"

"When it worked, I really wasn't thinking about my bat, or swinging my arms, or trying to hit the ball. I didn't decide to swing my bat. I just thought about seeing the ball like you told me, and my arms moved at the right time. I didn't have to think about my arms or the bat. It was like I didn't have to do anything!"

A smile spread across my face as I answered, "That's what I teach people—to think of not doing, while letting their helper do the work for them."

"You know a lot about baseball, Mom."

There was a wondering smile on Jared's face and, I am sure, no small expression of pride on my own. My son was quietly expressing his respect and admiration for what his mom, a mere girl, had been able to teach him about baseball. (Yet another citadel of belief was dashed on that day.)

Other than occasionally thinking with pleasure about the remainder of Jared's Little League career that season, during which he failed only once to have a hit at bat, I did not give our experiment any further thought. Several years later, however, students enrolled in my teacher-training course asked to apply the Technique to sports. I decided to try the batting experiment with them. I am not sure what I was expecting, but I was not expecting it to be the success that it was with Jared. I was wrong. With each student, the problems and tensions were virtually the same. They could not keep watching the ball when they swung the bat. Later, when they mastered seeing the ball and were told to move their bats, they lost their visual coordination again as they focused on feeling their arms and deciding to swing.
After they learned to see the ball and think of not swinging in order to let their helper move the bat as they simply watched the bat and ball make contact, I asked them to follow through with the swing. Invariably they stopped seeing the ball again. When they finally managed all three steps, their comments were remarkably the same.

“Wow! I didn’t swing the bat. It swung itself.”

“I didn’t have to decide to do it! That’s amazing!”

“How’d that happen?”

It was not until years later that a student offered to pitch and let me have a chance to try my own experiment. Afflicted with poor vision and bad depth perception from an early age, I had long since given up on ball sports. I picked up the bat and faced my pitcher with trepidation. Fifteen minutes later, just like those before me, my bat found the ball. There was a satisfying thwack as the ball flew forward.

“Amazing!” I heard myself saying, “I didn’t swing the bat!”
Body Matters: The Palpability of Invisible Computing

Thecla Schiphorst

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Body Matters: The Palpability of Invisible Computing

Thecla Schiphorst

Our physical technology continues to grow smaller. It is becoming more embedded within the many surfaces of our world: our clothing, buildings and even our own skin. Weiser, who coined the term *invisible computing*, remarked, “The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it” [1]. The era of invisible computing is not defined merely by miniaturization. It also brings with it a cognitive and creative shift from the visible to the multi-sensory and palpable realm of the invisible. As invisible computing brings technology closer to our own skin, our technologies must account for our bodily experience. This paper explores embodiment in the context of designing for technology. It offers an embodiment framework from the field of somatics that can contribute to the discourse of bodily experience in technology.

As a sense historically privileged by the Enlightenment, vision has influenced the definitions of knowledge, validity and experience [2,3]. Yet invisible computing, as originally defined by Weiser [4], is moving us beyond the visible, toward perceptually palpable interfaces. Concepts such as embodied computing and embodied interaction define design strategies that take advantage of our senses, accessing a richer and more fully articulated form of human being. Weiser’s definition includes a return to the “whole person,” engaging with practices in arts and humanities and focusing on experience. This aligns with the growing acknowledgement within human-computer interaction (HCI) of the value of designing for technology as experience [5]. As we continue to engage technology through a more richly articulated range of the senses, the body matters.

The Palpability of the Invisible

The metaphor of palpability refers to the need to articulate an increasing physical yet invisible embodiment of technologies. Palpability is defined as an intensity that is perceivable and can be felt. Gibson refers to the senses as *active* seeking mechanisms for understanding information in the world [6]. The roles of kinesthesia and movement are inseparable from perception, constantly cooperating in and coordinated with acts of perception [7]. Invisible computing necessitates the development of new models and metaphors that support design, creativity and use through embodiment.

The Body in the Mind—A Context for Embodied Interaction

Recent developments in the natural and social sciences support the argument for a greater articulation of embodiment in technology design. In cognitive science, researchers have strongly argued the embodied nature of perception and thought. Gibson [8] was among the first to explore the senses as perceptual systems; Damasio [9] acknowledged the neurophysiological coupling of feeling, thought and action; Polanyi [10] articulated the tacit dimension of knowing; Putnam [11] argued that value is inextricably tied to reason; and Johnson [12] describes truth as relative to embodied understanding:

*Imagination can be both formal and material, rational and bodily—there is not an unbridgeable gap between these two realms. . . . Once we no longer demand a disembodied (or nonphysical) rationality, then there is no particular reason to exclude embodied imagination from the bounds of reason* [15].

Within HCI we have also seen recent growth in exploration of embodied computing. This includes approaches to interaction design that express experience through embodied goals [14], attention to sensing systems [15], aesthetics [16,17] and situated contexts [18,19], and that focus on the emerging roles of performance [20]. McCarthy and Wright, for example, have suggested placing “felt-life” at the center of

ABSTRACT

There is an emerging recognition of the value of designing for technology as experience, and of the point that the body matters in the context of technology design. Mark Weiser coined the term invisible computing, remarking that the most profound technologies disappear into the fabric of everyday life. This paper offers a framework from the field of somatics to contribute to the discourse of embodiment and experience in technology, particularly with regard to the body in everyday life. Somatics brings with it epistemologies of practice and embodied approaches to learning and interacting that focus on attention, context and awareness. This paper presents a set of design examples that demonstrate ways in which somatics can be applied to technology design.

Fig. 1. The whisper workshop: modeling connection and extension. (© Thecla Schiphorst)
The lived experience in technology, particularly in the discourse of embodiment and the concept of retraining attention in order to increase awareness of one’s physical state. This technique is also practiced in Noh and Butoh traditions, as well as in movement therapies that work to retrain sensorimotor habits. Consciously slowed motion enables the body to shift its attention to an immersive state in relation to its environment, wherein attention is intensified and sensory details are sharpened.

Augusto Boal terms this type of experiential exercise de-specialization. He states that in our everyday lives, the senses suffer. We feel very little of what we touch, listen to very little of what we hear, and see very little of what we look at. We feel, listen and see according to our specialty. The adaptation is both atrophy and hypertrophy. In order for the body to be able to send out and receive all possible messages, it has to be re-harmonized through exercises and games that focus on de-specialization.

Boal’s goals in theater are to create imaginative, social and political agency. His work is premised on the notion that agency at the bodily level (agency of the self) enables agency at the social and political levels. Many exercises in somatics and performance focus on this idea of retraining attention in order to increase awareness and agency through the body and can be applied to many levels of awareness that extend beyond the personal.

Somatic learning expands the range of what Thomas Hanna terms volitional attention. Csikszentmihalyi [35] has acknowledged that human experience operates within a limited field of attention. Somatics considers attention to be generative, which enables it to be augmented and increased through a process of somatic learning.

CASES AND STRATEGIES FROM ART AND DESIGN

Experience is felt, palpable, perceived and lived. How can these concepts be used in design processes that cultivate attention? Somatic techniques increase the resolution of our attention and the resolution of our experience. Can user experience be designed to such a degree that experience itself becomes personalized, developing degrees of skill and refinement of the use of our body states, refining the inseparability of mind from body?

Can user-experience be designed to acknowledge the shifting focus between the world and the self? Can it explore the concept of generating user attention rather than competing for the limited attention space of the user?

I present three cases that apply somatic principles. In Case One, a series of design workshops is used to illustrate an exploratory approach to creating an interaction model through participants’ attention to their own lived experience. In Case Two, the physiological data of breath is used in order to create a heightened and empathetic connection between shared participants wearing networked garments. In Case Three, touch and tactile quality recognition is used to explore qualitative interaction, and experience, intimacy and play are a central theme.

Case One: whisper[s]: wearable body architectures

This case illustrates the outcome of a series of exploratory workshops used in the design process of the installation whisper[s]. The goal was to explore how people pay attention to their own body states and share those states with others in a space (Fig. 1). A range of techniques was used to train attention and awareness. The workshops relied on improvisation, props, ritual space and placebo objects. Very little digital technology was introduced at this stage. The central theme of the workshops was that participants were to employ simple acts of “paying attention.” For example participants were asked to listen, notice, touch, move and feel. Participants were asked to imagine and visualize, to focus on bodily experiences such as breath, heartbeat, stillness and slow-motion movement. The goals of the workshops were to design experience that could be replicated, reenacted and replayed in the context of a public art installation using wearable computing technology. The public art space environment could be simultaneously intimate, playful and social, while allowing a level of awareness of the participant’s “selves.”

A set of examples from three of the five workshops is described below.

The listen workshop. One of the major themes of the artwork (and of the workshops) is the notion of “paying attention”
The design for the installation centered on measuring physiological data as a representation of oneself: data that we do not normally pay attention to in everyday life but can easily access. How do we perceive the direction of attention to our body data? Participants were asked to find places for themselves in the space and to remain silent. Each participant was given a pair of earplugs and they were then left alone with themselves with no further instructions for about 15 minutes. Each participant was then handed a card (Fig. 2). The card asked the questions: What did you hear? How did you hear? What did it feel like?

This is the simplest of experiments. Deprived of its external hearing, the body can become aware of internal sound otherwise made invisible by louder external sounds. We are removed from our own ears, but not from our hearing. In performance, artists such as Pauline Oliveros and Augusto Boal have created practices such as “deep listening” and “listening to what we hear,” which probe and access these very same questions of experience. The responses to the very simple question What did you hear? focus on access to this level or resolution of experience. Responses indicated the participants’ discovery of the internal soundscape:

Heartbeat; earplugs as they settle, breath, slopping sounds from others in the room; humming noise; myself; contact with my own body.

This process seems to trigger strong emotions, ranging from slight unease to feelings of fear or elation, as shown in the answers to the question What did it feel like?

I felt self-consciousness about all the sound that body makes; it wasn’t sound; it was movement, vibration. I could hear the movement of my body.

Some workshop participants were able to recognize that listening occurs not only through the ears, but also through the bones, the resonant cavities of vibration in the body, that the body is a metaphor for listening, and that what is heard is not only sound but also movement, vibration, feeling and sensation.

The <between> workshop. The creation of protocols that facilitate sharing and exchange of our body as a complete unit without touching or engaging made me feel close.

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networked skirts (Fig. 5). This example illustrates how our own body data can be used to create and share awareness in an intimate way in a social space. Each *exhale* skirt is sewn from lush vibrant raw silk in rich saturated colors. The skirts are lined with small vibrators that synchronize in correspondence with the participants’ breath rhythm. Breath can be shared (given and received) through the use of RFID tags sewn into pockets in the side of the skirts. An LED array on the surface of the skirt presents the breath rhythm as a moving illuminated image (Color Plate G No. 2). *exhale* creates a palpable interface wherein physical vibration created by small motors and the tiny movement of air created by small fans respond intensely to breath and provide alternate “physical displays” for the body [38].

The exploration of breath in *exhale* is based on the idea of creating body states through somatic awareness. Shared breath creates empathic connections between participants and causes vibrations in the linings of the skirts and light in response to breathing patterns. Damašio [39] has studied the connection of “feeling states” in the body and maintains that a given feeling state is associated with specific physiological patterns (such as breath rhythm) along with a set of processes including thought patterns and emotion. His research suggests that these “feeling” body-states are an interconnected set of feeling, thought, emotion and physiological functioning: Each of these is present and affects the other. He asserts that a body-state can be induced through attention to any one of the inter-connected patterns: Attention to physiological patterning (breath, for example) can thus induce a body state. This interconnectedness between physical data and the state of the body creates a complex but coherent set of body-data and experience.

### Case Three: soft(n) tactile networks

*softn* is an interactive public art installation, created in collaboration with the V2_Lab development team, based on exploring emerging network behavior through interaction between a group of 10 soft networked objects (Fig. 6). Each soft object has a specially designed hand-sewn tactile surface that recognizes 12 tactile qualities or actions based on Laban’s Effort Analysis. Rudolf Laban’s movement analysis system [40] is based in experiential practices of dance [41,42]
that model qualities of movement. Within HCI this knowledge can be applied to gestural recognition, modeling qualitative movement characteristics such as intention, attention and body state.

This installation illustrates how somatic movement systems based on quality of experience can be computationally applied to human-computer interaction. The parameters that determine the tactile qualities are shown in Table 1. Implemented tactile qualities include jab, knock, touch, caress, glide, tap, pat and float. One can think of softn as a counterpoint to, or a critique of, the hard: a survival strategy for interaction that allows misplaced action, mistake, forgiveness, a bad attitude, weakness, stillness, giving in. softn allows critique through the computational act of quality, where the quality of caress defines the interaction and response from each object. The objects have three states: inactive (sleeping), active (listening to other objects in the family) and interactive (being touched or thrown about).

The soft objects respond to tactile caress by actuating light, sound and vibration. Small tonal sounds, sighs and melodic “dialogue” are shared among the objects when they are touched. The objects form an ecology of sound, vibration and light. Each softn touch pad is hand sewn using a specially constructed combination of conductive fiber, conductive foam and everyday needle and thread. This illustrates the use of domestic cottage-industry approaches to create “hand-made” input devices that share algorithmic intelligence with other tactile heuristics normally applied to consumer input devices [43, 44]. The groups of soft objects that are strewn about and tumbled within a public urban space are networked to one another and create a group-body based on tactile input. The softn objects communicate wirelessly to each other within their network.

softn includes the development and testing of an interaction model based on input heuristics of touch, based in turn on Laban effort-shape analysis, a somatic system of movement analysis.

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**Table 1. Laban Touch Qualities extracted from softn input surface.**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Pressure</th>
<th>Time</th>
<th>Size</th>
<th>Number</th>
<th>Space (speed)</th>
<th>Path (direction)</th>
<th>Disposition (pressure)</th>
</tr>
</thead>
<tbody>
<tr>
<td>touch-effort</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>tap</td>
<td>soft</td>
<td>short</td>
<td>small</td>
<td>e</td>
<td>stationary</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>pat</td>
<td>soft</td>
<td>short</td>
<td>big</td>
<td>one</td>
<td>stationary</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>touch</td>
<td>soft</td>
<td>long</td>
<td>small</td>
<td>one</td>
<td>stationary</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>stroke</td>
<td>soft</td>
<td>long</td>
<td>o</td>
<td>a</td>
<td>travelling</td>
<td>straight</td>
<td>o</td>
</tr>
<tr>
<td>glide</td>
<td>soft</td>
<td>long</td>
<td>o</td>
<td>a</td>
<td>travelling</td>
<td>wandering</td>
<td>o</td>
</tr>
<tr>
<td>hold</td>
<td>soft</td>
<td>long</td>
<td>big</td>
<td>one</td>
<td>stationary</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>poke/jab/flick</td>
<td>hard</td>
<td>short</td>
<td>small</td>
<td>one</td>
<td>stationary</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>knock</td>
<td>hard</td>
<td>short</td>
<td>medium</td>
<td>one</td>
<td>stationary</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>slap/panch</td>
<td>hard</td>
<td>short</td>
<td>long</td>
<td>one</td>
<td>stationary</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>press</td>
<td>hard</td>
<td>long</td>
<td>o</td>
<td>a</td>
<td>stationary</td>
<td>n/a</td>
<td>constant</td>
</tr>
<tr>
<td>knead</td>
<td>hard</td>
<td>long</td>
<td>o</td>
<td>many</td>
<td>stationary</td>
<td>n/a</td>
<td>varying</td>
</tr>
</tbody>
</table>

**Fig. 6.** softn, installation, 2007. (© Thecla Schiphorst) Tactile networked objects.

**CONCLUSIONS**

This article has offered a framework from the field of somatics, especially with regard to the body in everyday life. The design examples use somatics techniques in the design of embodied interaction. In somatics, the body matters and defines our subjective selves within experience. The concept of palpable yet invisible interfaces is presented in the light of emerging exploration within HCI of experience, embodiment, subjectivity and felt life. The call to experience can be explored through valuing subjectivity and the foundational constituent knowledge of embodied approaches within interaction design. One of the promises of the invisible computer is that by the computer’s very disappearance, we are left with ourselves in our world and the opportunity to perceive ourselves more clearly in connection to our own felt life. Perhaps the invisible computer can make visible connections to ourselves that we were not able to perceive when the mechanisms of physical technology were “in the way,” obscuring our lines of sight and insight.
Acknowledgments

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7. Gibson [3].

8. Gibson [3].


21. McCarthy and Wright [3].


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25. M. Foucault, The Hermeneutics of the Subject: Lectures at the Collège de France 1981–1982, F. Geron (ed.) (New York: Palgrave Macmillan, 2004). This refers to an analysis of Foucault’s “care of the self” in his late-work The Hermeneutics of the Self, in which Foucault suggests that the Delphic prescription “know yourself” should be understood in subordination to the precept of “the care of the self” as a practice of subjectivity (the historical tradition of first-person practices). He distinguishes this from the idea of “knowledge” in the Cartesian moment, which historically re-qualified the importance of “knowing the self” while “discrediting the practice of ‘the care of the self’.” The original Heideggerian form of activating knowledge through practices of “the care of the self” as presented by Foucault, has significant resonances with the form of contemporary somatic body-based epistemologies of practice.


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39. Damasio [9].


43. Schiphorst [15].


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Embodied affectivity: on moving and being moved

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INTRODUCTION

Emotions may be considered some of the most complex phenomena of subjective experience. This is mirrored by the host of different and often opposing emotion theories both in philosophy and psychology. Of the many attempts to reduce the complexity of emotions to a more simplified concept, two should be mentioned. The first focuses on their bodily component, as in the famous theory of James and Lange (James, 1884), simply put: we do not shiver because we are scared of the lion, but we shiver, and this is what we feel as our fear. In other words, emotions are feelings of bodily changes. This counter-intuitive assumption has been widely criticized for neglecting the intentional content or “aboutness” of emotions.

On the other hand, the contrary theory seems no less one-sided: according to prevailing cognitive approaches (Solomon, 1976; Lyons, 1980; Nussbaum, 2001), an emotion mainly consists in an act of evaluation or appraisal of a given situation. The bodily experience of emotions is then regarded as just an additional quale without further relevance (Gordon, 1987) or serving the limited purpose to assure us that an emotion is going on (Lyons, 1980). Again simplified: we believe or judge the lion to be dangerous, want to run away, and this is our fear of him. However, belief-desire concepts of emotions have been notoriously unable to capture their experiential and phenomenal aspect. A purely cognitive or functional approach to the phenomenon loses its peculiar self-afflicting character. In particular, it fails to account for the changing intensity of emotions: it seems virtually impossible to indicate what a more intense anger, shame, or fear should be without referring to bodily experience (e.g., to one’s increased sense of muscle tension, breath restriction, heated face or pounding heart). Cognitions as such do not differ in intensity. We may put the belief that “the lion is dangerous” into the comparative “the lion is very dangerous,” or we may repeat the thought with high frequency, but this does not yield a different affective experience unless we feel the “very” or the repetition as expressing a more activated, tense or stressful bodily state (Lang et al., 1993; Reisenzein, 1994). There is, however, no necessity and no indication to impose a linear causality model upon the complex phenomena of emotions (Boettiger, 2012). Given the divergent and inconclusive findings under the assumption of linear causality, models of circular causality may lead to a more appropriate understanding of emotional phenomena.

In the past decades a growing body of research on embodiment has demonstrated that not only bodily sensations, but also bodily postures, gestures and expressions are inherent components of emotional experience and tacitly influence the evaluation of persons, objects and situations as well as memory recall. To provide some examples:

- Riskind (1984) found that individuals recalled more negative life events when sitting in a slumped position, and more positive events when sitting in an upright position.
- Strack et al. (1988) demonstrated that activation of the smiling muscle (by asking participants to hold a pen between their
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2. Conversely, when individuals’ expressive movements are inhibited, the experiencing of the associated emotions as well as the processing of corresponding emotional information is impaired. This is even the case when the information is presented in a merely cognitive or non-expressive way (as shown by the study of Havas et al., 2010, above).

Empirical findings thus show that embodiment has a far reaching influence on our emotional life. How may this influence be adequately understood? While we know that proprioceptive body feedback (based on afferent neural pathways from the body to the brain) is one of the responsible mechanisms (Hatfield et al., 1994; Koch, 2011), its interplay with the emotional perception and evaluation of a given situation still needs to be clarified. If we want to integrate the existing empirical research results into a comprehensive model of embodied affectivity, it seems advisable to follow a step-by-step approach: We will first consider emotions under different aspects, then we will try to integrate these aspects into an embodied and enactive concept of emotions. Finally, we will apply this concept to the special situation of social interactions or what may be called “embodied interaffectivity.”

WHAT ARE EMOTIONS?

In a first approximation, emotions may be regarded as affective responses to certain kinds of events of concern to a subject, implying conspicuous bodily changes and motivating a specific behavior (De Sousa, 2010). Accordingly, we will consider emotions under the aspects of (a) affective intentionality, (b) bodily resonance, (c) action tendency, and (d) function and significance.

(a) Affective intentionality. There is wide agreement among philosophers and psychologists that emotions are characterized by intentionality—they relate to persons, objects, events and situations in the world (see e.g., Solomon, 1976; Frijda, 1994; De Sousa, 2010). However, this intentionality is of a special kind: it is not neutral, but concerns what is particularly valuable and relevant for the subject. In a sense, emotions are ways of perceiving, namely attending to salient features of a situation, giving them a significance and weight they would not have without the emotion. Referring to Gibson’s (1979) concept of affordances (that means, offerings in the environment that are available to animals, such as a tree being “climbable,” water “drinkable,” etc.), one could also speak of affective affordances: things appear to us as “important,” “worthwhile,” “attractive,” “repulsive,” “expressive,” and so on. Without emotions, the world would be without meaning or significance; nothing would attract or repel us and motivate us to act.

Of course, this meaning-making implies an evaluative or appraising component which should not, however, be conceived in terms of propositional attitudes (believing that p is the case, for example, believing that a lion is dangerous; cf. Lyons, 1980); otherwise, emotions could not be experienced by small children or higher animals lacking language. The evaluative aspect of affective intentionality is not dependent on verbally structured judgements, but on more basic cognitive-emotional schemes which are acquired in the course of affect-inducing experiences. Thus, an approaching lion will be immediately perceived and felt as a dangerous object once one has heard a lion’s terrible roaring before, seen its leap toward a prey, etc. It has then acquired a threatening appearance which does not necessarily imply a belief such as “this is a lion,” “lions are dangerous,” etc. Of course there are emotional situations which are largely determined by higher forms of cognition (e.g., if an emotionally relevant information is provided
through the entire body (Gendlin, 1967). Bodily resonance may be felt locally as a lump in the throat, a tightening of the chest (e.g., clenching one’s fist or one’s jaws, moving backwards or forwards, bending or straightening oneself, etc.). Particularly rich fields of bodily resonance are the face and the gut. Thus, for example, sadness may be felt locally as a lump in the throat, a tightening in the chest or in the belly, a tension around the eyes, a tendency to weep, or globally as a sagging tendency or a painful wave spreading through the entire body (Gendlin, 1967). Bodily resonance is also related to Damasio’s concept of the “somatic markers,” consisting of interoceptive and proprioceptive feedback from the body that needs to be integrated with other more cognitive information in the frontal lobe of the brain in order to guide one’s behavior, in particular in every day decision-making (Damasio, 1994, 1996).

In sum, as William James put it, the body is a most sensitive “sounding-board” in which every emotion reverberates (James, 1884), both within and between us. In addition, our bodies have a varying degree of permeability (“Durchlässigkeit”; Lewin, 1935), affectability and responsivity (e.g., Stern, 1985; Trevathan, 2009) at any given point in time. The tired body is more permeable than the wake body, the drunk body more permeable than the sober body (Lewin, 1935). At the same time, these bodily feelings have an immediate repercussion on the emotion as a whole: Feeling one’s heart pound in fear raises one’s anxiety, feeling one’s cheeks burn with shame increases the painful experience of exposure and humiliation (Ekman et al., 1972). Therefore, bodily feelings should not be conceived as a mere by-product or add-on, distinct from the emotion as such, but as the very medium of affective intentionality. Being afraid, for instance, is not possible without feeling a bodily tension or trembling, a beating of the heart or a shortness of breath, and a tendency to withdraw. It is through these sensations that we are anxiously directed toward a frightening situation.

According to traditional appraisal-theories (Lazarus, 1982), the evaluation of a given situation is a primary and separate component of emotions which precedes any bodily changes. From an embodied perspective, however, it is the lived body with its background sensations that is co-constitutive of the evaluation, which means that we should rather speak of an “embodied appraisal” (Prinz, 2004). For example, when feeling tired or exhausted, a familiar way uphill appears steeper and longer than normally. This appraisal does not result from a separate evaluative judgement, but from the very mismatch between one’s bodily capacity and the task one faces. The hill is “too high,” that means it is perceived in this way through the tired, incapable body. Even in cases where emotionally relevant information is presented in a merely abstract form (such as the text with negative content in the Botox study by Havas et al. see above), the evaluation obviously also depends on the simultaneous bodily resonance. More generally, our feeling body is the way we are emotionally related to the world, or in other words, affective experiences are bodily feelings-toward (Goldie, 2000). In emotions, there is no separation between an appraisal and a bodily component for they are only realized as a synthesis or “full circle” of all mutually interacting components.

(c) Action tendency. Bodily resonance of emotions is not restricted to autonomic nervous system activity or facial expression (which are in the focus of most empirical studies), but includes the whole body as being moved and moving. Fear, for example, does not only mean a raised heart beat or widely opened eyes but also the urge to break free, to flee or to hide (Sheets-Johnstone, 1999). The term “emotion” is derived from the Latin enmovere, “to move out,” implying that inherent in emotions is a potential for movement, a directedness toward a certain goal (be it attractive or repulsive) and a tension between possible and actual movement. Correspondingly, Frijda (1986) has characterized emotions in terms of action readiness, according to the different patterns of action which they induce: approach (e.g., desire), avoidance (e.g., fear), being-with (enjoyment, confidence), attending (interest), rejecting (disgust), non-attending (indifference), agonistic (anger), interrupting (shock, surprise), dominating (arrogance), and submitting (humility, resignation).
Similarly, according to Kafka (1950) and De Rivera (1977), there exist four basic emotional movements: moving oneself “toward the other” (e.g., affection, mourning), moving the other “toward oneself” (e.g., desire, greed), moving the other “away from oneself” (e.g., disgust, anger) and moving oneself “away from the other” (e.g., fear, disgust). The four are related to the gestures of giving, getting, removing and escaping. These basic movements are connected to a bodily felt sense of expansion or contraction, relaxation or tension, openness or constriction, etc. In anger, for example, one feels a tendency of expansion toward an object in order to push it away from self. In affection, one feels a relaxation, opening and emanation toward an object or person. Emotions can thus be experienced as the directionality of one’s potential movement, although this movement need not necessarily be realized in physical space; they are phenomena of lived space (Fuchs, 2007).

(d) Functions and significance. On the basis of the analysis so far, the role of emotions for the individual may be determined as follows: Emotions “befall us”; they interrupt the ongoing course of life in order to inform us, warn us, tell us what is important and what we have to react upon. They (re)structure the field of relevance and values; some of our plans, intentions or beliefs must be revised (Downing, 2000). Emotions thus provide a basic orientation about what really matters to us; they contribute to defining our goals and priorities. At the same time, they sketch out a certain scope and direction of possible responses, which are complementary to the meaning the emotion gives to the situation. Bodily resonance, autonomic arousal and musular activations make us become ready to act: in anger we prepare for attack, in fear we prepare for flight, in shame we want to hide or disappear, in love we want to approach and be approached. Emotion may thus be regarded as a bodily felt transformation of the subject’s world, which solicits the lived body to action. However, even when the action tendency of emotions does not win through, they still retain an expressive function: by indicating the individual’s state and possible action to others, they serve a communicative function in social life which will be explained in the section on “interaffectivity.”

AN EMBODIED AND EXTENDED CONCEPT OF EMOTIONS

We now have gathered the necessary components that may be integrated into an embodied and extended model of emotions:

1. Emotions emerge as specific forms of a subject’s bodily directness toward the valences and affective affordances of a given situation4. They encompass subject and situation and therefore may not be localized in the interior of persons (be it their psyche or their brain). Rather, the affected subject is engaged with an environment that itself has affect-like qualities. For example, in shame, an embarrassing situation and the dismissive gazes of others are experienced as a painful bodily affection which is the way the subject feels the sudden devaluation in others’ eyes. The emotion of shame is extended over the feeling person and his body as well as the situation as a whole (on this extended concept of affectivity cf. Schmitz et al., 2011).

2. Emotions imply two components of bodily resonance:
   - a centripetal or affective component, i.e., being affected, “moved” or “touched” by an event through various forms of bodily sensations (e.g., the blushing and “burning” of shame);
   - a centrifugal or emotive component, i.e., a bodily action readiness, implying specific tendencies of movement and directedness (e.g., hiding, avoiding the other’s gaze, “sinking into the floor” from shame).

On this basis, feelings may be regarded as circular interactions or feedback cycles between centripetal affection and centrifugal e-motion (cf. Figure 1). Being affected by affective affordances of a situation triggers a specific bodily resonance (“affection”) which in turn influences the emotional perception and evaluation of the situation and implies a corresponding action readiness (“e-motion”). Affective intentionality consists in the entire interactive cycle, which is mediated by the resonance of the feeling body. Thus, in affectivity we are moved by movement (impression, affection) and moved to move (expression, e-motion), indicating the kinetic-kinaesthetic ambiguity of the body (Sheets-Johnstone, 1999).

3. Bodily resonance thus acts as the medium of our affective engagement in a given situation. It imubes, taints and permeates the perception of this situation without necessarily stepping into the foreground. In Polanyi’s terms, bodily resonance is the proximal, and the perceived situation is the distal, component of affective intentionality, with the proximal component receding from awareness in favor of the distal (Polanyi, 1967). This may be compared to the sense of touch which is at the same time a self-feeling of the body (“proximal”) and a feeling of the touched surface (“distal”); or to the subliminal experience of thirst (“proximal”) which first becomes conspicuous as the perceptual salience of water flowing nearby (“distal”).

4. If the resonance or affectability of the body is modified in specific ways, this will change the person’s affective perception accordingly. This is the common basis of the studies on embodiment and emotions that we mentioned above. Thus, a lack of resonance (e.g., after injection of botulinum toxin) will impede the perception of corresponding affective affordances in the environment. Conversely, increasing a certain bodily feeling (e.g., holding a hot cup of coffee), adopting a certain position or moving in a certain way favors the correlated affective perception. Thus, the different components of the affection-intention-motion cycle influence one another.
The last point is of particular psychotherapeutic importance, for it shows that emotions may not only be influenced by cognitive means (i.e., by changing the cognitive component of the cycle), but also by modifying the bodily resonance. It can be diminished as well as increased. The first is the case in habitual but also by modifying the bodily resonance. It can be diminished.

Emotions thus imply two components of bodily resonance or feedback:

- Self- or individual resonance: proprio- and interoceptive feedback providing the organism with useful information from body postures, gestures or sensations (Zajonc and Markus, 1984; Hatfield et al., 1994: the body as “interface” between cognition and affect).
- Interactional or interbodily resonance: dynamic mutual feedback between two bodies (e.g., you lift your arms and I feel slightly “uplifted”). This body feedback can occur through the visual, auditory or tactile channel (such as from a handshake or an embrace; Koch, unpublished Manuscript), but also through the kinaesthetic channel (such as from directional movements; e.g., Koch et al., 2011).

This means that in every social encounter, two cycles of embodied affectivity (cf. Figure 1 above) become intertwined, thus continuously modifying each subject’s affective affordances and resonance. This complex process may be regarded as the bodily basis of empathy and social understanding.

To illustrate this (Figure 2), let us assume that the SELF (A) is a person whose emotion, e.g., anger, manifests itself in typical bodily (facial, gestural, interoceptive, etc.) changes. He feels the anger as the tension in his face, the sharpness of his voice, the arousal in his body etc. This resonance is an expression of the emotion at the same time, i.e., the anger becomes visible and is perceived as such by the OTHER (B). But what is more, the expression will also produce an impression, namely by triggering corresponding or complementary bodily feelings in the OTHER. Thus, As sinister gaze, the sharpness of his voice or expansive bodily movements might induce in B an unpleasant tension or even a jerk, a tendency

According to (Darwin, 1872/1904), emotional expressions once served particular action functions (e.g., baring one’s teeth in anger to prepare for attack), but now accompany emotions in rudimentary ways in order to communicate these emotions to others. Evolutionary psychologists have advanced the hypothesis that hominids have evolved both with increasingly differentiated facial expressions and with sophisticated capabilities of understanding these affect displays. In any case, though strongly varying between and within cultures, emotional expression is a crucial facet of interpersonal communication in all societies.
FIGURE 2 | Interaffectivity. The figure is an integration of Koch (2011), Froese and Fuchs (2012), and Fuchs (2013). Interaffectivity includes body feedback (i.e., the impression function within self and other) which is necessary for interbodily resonance. Components of interbodily resonance are: mirroring or complementing movements, body awareness (via proprioceptive body feedback), and kinaesthetic empathy; they are psychotherapeutically important in phenomena such as somatic countertransference (Pallisero, 2002).

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to withdraw, etc. (similarly, shame that one witnesses may induce embarrassed aversion, sadness a tendency to connect and console, and so forth). Thus, B not only sees the emotions in the A’s face and gesture, but also senses it with his own body, through his own bodily resonance.

However, it does not stay like this, for the impression and bodily reaction caused in B in turn becomes an expression for A. It will immediately affect his bodily reaction, change his own expression, however slightly (e.g., increasing or decreasing his expression of anger), and so forth. This creates a circular interplay of expressions and reactions running in split seconds and constantly modifying each partner’s bodily state. They have become parts of a dynamic sensorimotor and interactive system that connects both bodies in interbodily resonance or intercorporeality (Merleau-Ponty, 1964). Of course, the signals and reactions involved proceed far too quickly to become conscious as such. Instead, both partners will experience a specific feeling of being connected with the other in a way that may be termed “mutual incorporation” (Fuchs and De Jaegher, 2009). Each lived and felt body reaches out, as it were, to be extended by the other. In both partners, their own bodily resonance mediates the perception of the other. It is in this sense that we can refer to the experience of the other in terms of an embodied perception, which, through the interaction process, is at the same time an embodied communication.

No mental representation is necessary for this process. There is no strict separation between the inner and the outer, as if a hidden mental state in X produced certain external signs, which Y would have to decipher. For X’s anger may not be separated from its bodily expression; and similarly, Y does not perceive X’s body as a mere object, but as a living, animate and expressive body that she/he is coupled with.

Nor is a simulation required for the process of mutual incorporation. We certainly do not simulate the other’s angry gaze or voice, even less his anger, but rather feel tense, threatened or even invaded by his expressive bodily behavior. Bodily sensations, tensions, action tendencies, etc. that arise in the interaction do not serve as a separate simulation of the other person, but are fed into the mutual perception. In Polanyi’s terms, one could also say that the felt bodily resonance is the proximal, the other’s perceived body is the distal component of one’s empathic perception, with the proximal component receding from awareness in favor of the distal (Polanyi, 1967). Stuart (2012) has recently coined the term “enkinesis,” that means, “feeling one’s own movements into the other,” or: empathy through subliminal co-movement. It is in this sense that we can refer to the experience of the other in terms of “embodied” perception, which, through the interaction process, is at the same time an “embodied” communication. In Merleau-Ponty’s account:

“The communication or comprehension of gestures comes about through the reciprocity of my intentions and the gestures of others, of my gestures and the intentions discernible in the conduct of other people. It is as if the other person’s intentions inhabited my body and mine his” (Merleau-Ponty, 1962).

As we can see, the concept of mutual incorporation leads to the opposite of the representationalist account: Primary social understanding is not an inner modeling in a detached observer, but the other’s body extends onto my own, and my own extends onto the other.

This can perhaps best be studied in early childhood. Emotions primarily emerge from and are embedded in dyadic interactions of infant and caregiver. Stern (1985) has shown in detail
how emotions are cross-modally expressed, shared, and regulated. Infants and adults experience joint affective states in terms of dynamic flow patterns, intensities, shapes, and vitality affects (for example, crescendo or decrescendo, fading, bursting, pulsing, effortful or easy, etc.) in just the way that music is experienced as affective dynamics. This includes the tendency to mimic and synchronize each other’s facial expressions, vocalizations, postures, movements, and thus to converge emotionally (Condon, 1979; Hatfield et al., 1994). All this may be summarized by the terms affect attunement and interaffectivity (Stern, 1985; p. 132): The emerging affect during a joyful playing situation between mother and infant may not be divided and distributed among them. It arises from the “in-between,” or from the over-arching process in which both are immersed. Affect attunement is carried by kinesthetic empathy (Kestenberg, 1975; Fischman, 2008), which is also employed in dance/movement therapy diagnostics and intervention (for a systematization of forms of attunement and mirroring see Eberhard-Kaechele, 2012).

Affect attunement was first investigated by Kestenberg (1975); Kestenberg and Sossin (1973, 1979), who systematized it into quality and shape attunement and described developmental regularities and sequences. Kestenberg emphasized that in the individuation process, partial attunement of mother and child was more productive than complete attunement to serve the child’s development. A basic dimension of meaning are smooth vs. sharp reversals between rhythms (Koch, 2011). Via kinesthetic empathy, researchers can notate body rhythms (Figure 3) that may be used to analyse affect attunement differentially (Koch, 2014). These rhythm curves reflect what Stern calls “vitality affects” or “vitality contours” (Stern, 1985, 2010). Shared vitality affects then form a vital part of our emotions.

Thus, emotions are not inner states that we experience only individually or that we have to decode in others, but primarily shared states that we experience through interbodily affection. Even if one’s emotions become increasingly independent from another’s presence in the course of childhood, intercorporeality remains the basis of empathy: There is a bodily link which allows emotions to immediately affect the other and thus enables empathic understanding without requiring a Theory of Mind or verbal articulation (Fuchs and De Jaegher, 2009). On this basis, we have created a short scale that measures the degree of feeling understood by and understanding of others through movement. The Embodied Intersubjectivity Scale (EIS; see Appendix) consists of ten items measuring the degree of closeness created by different forms of attuning and mirroring in movement. It complements the Body Self-Efficacy Scale (BSE; see Appendix), which measures the body-based “I can’t” of a person (Husserl, 1952) also with 10 items. Perceived body self-efficacy is related to a positive body image, positive movement-based affect (MBAS; Koch, 2014) and the ability for embodied interaffectivity (Appendix).

**(PSYCHO)PATHOLOGICAL IMPLICATIONS**

The model of embodied affectivity that we have presented may gain additional plausibility from different kinds of disturbances which occur in psychopathology. We will illustrate its implications by using the examples of (1) anxiety disorder, (2) depression, (3) Parkinson’s disease, (4) alexithymia, and (5) autism.

1. **Anxiety disorders** are characterized by a heightened alert of the body which reacts to threatening affective affordances in the environment with intense feelings of oppression mainly in throat, breast or gut (corresponding physiologically to muscular tension, trembling, palpitation, hyperventilation, sweating, etc.)6. This bodily affection motivates, on the one hand, a hypervigilant perception: The anxious person scans the environment for threatening cues and anticipates lurking danger. On the other hand, the bodily resonance also implies a specific action tendency, namely to escape the oppressing situation through flight or to avoid it in advance. Phobias particularly related to space, such as agoraphobia, claustrophobia or acrophobia, dynamize the otherwise static quality of experienced space and illustrate the overall spatial structure of anxiety as encompassing body and environment.

2. In contrast, a lack or loss of bodily affectability is characteristic of severe depression. The constriction, rigidity and missing tension-flow modulation (neutral flow; Kestenberg, 1975) of the lived body in depression leads to a general emotional numbness and finally to affective depersonalization (Fuchs, 2005). The deeper the depression, the more the affective qualities and atmospheres of the environment fade. The patients are no longer capable of being moved and affected by things, situations or other persons. They complain of a painful indifference, a “feeling of not feeling” and of not being able to sympathize with their relatives any more. In his autobiographical account, Solomon describes his depression as “... a loss of feeling, a numbness, (which) had infected all my human relations. I didn’t care about love; about my work; about family; about friends ... ” (Solomon, 2001; p. 45). Thus patients feel disconnected from the world; they

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6 Similarly, in Posttraumatic Stress Disorder (PTSD) there is an increased bodily responsivity (racing heart, dyspnea, fear-sweat, sickness) to certain environmental triggers that are related to former traumatic experiences (sights, sounds, smells, etc.), that means, the body resonance is shaped by a traumatic body memory (van der Kolk, 1994; Fuchs, 2012).
lose their participation in the interaffective space that we normally share with others (Fuchs, 2013).

(3) In some way similar to depression, we find in progressed Parkinson's disease a “freezing” of face and body, which leads to loss of emotional expressivity. As a result, patients tend to experience a decreased intensity of their emotions and complain of no longer being able to participate in interaffective exchange with others as before. Studies have also found that patients with Parkinson's disease were less accurate than healthy controls in decoding angry, sad and disgusted facial expressions of others, pointing to a lack of bodily resonance as the proximal component of affective perception (see Mermillod et al., 2011, for an overview).

(4) Persons characterized by alexithymia have marked difficulties to identify, differentiate and describe their own emotions, while at the same time being unable to recognize the affective nature of bodily sensations associated with certain emotions (Taylor and Taylor, 1997). This is often accompanied by a lack of understanding of the feelings of others, which leads to unempathic emotional responding (Hesse and Floyd, 2008). Alexithymia is particularly frequent in patients with somatoform disorders who are have often problems to relate their bodily resonance to corresponding affective situations, leading to detached feelings of pressure, burning, pain, etc., which are then attributed to assumed somatic illnesses (Duddu et al., 2003). Moreover, interoceptive sensitivity, measured as a person's ability to accurately perceive one's heartbeats at rest, has been found to be reduced in somatoform patients which was associated with a reduced capacity of emotional self-regulation (Pollatos et al., 2011; Weiß et al., 2014). Interoceptive sensitivity normally facilitates successful self-regulation by providing a fine-tuned feedback of the present emotional state (Füstös et al., 2011).

What is obviously lacking in alexithymia is the proximal-distal structure of affective intentionality: Whereas bodily resonance normally functions as the proximal medium of our affective perception, for alexithymic patients their bodily reactions seem unrelated to affective affordances of a given situation, which means that the full circle of affectivity does not come about. Bodily sensations of resonance either are not felt at all, or they may come to the fore separately, instead of receding from awareness in favor of affective intentionality. In both cases, this is connected to a sense of emotional detachment of patients from themselves. Pathogenetically, a lack of interaffective mirroring and feedback in early childhood seems to play a major role: If caregivers are incapable of recognizing and validating emotional expressions in the child, this can impair the child’s capacity to understand and differentiate emotional states within himself as well as in others (Graerne and Bagby, 2000).

(5) Finally, autism or autistic spectrum disorder may be regarded as a disturbance of embodied interactivity, namely as a lack of perceiving others’ expressions, gestures and voicings in terms of affective affordances. Correspondingly, eye tracking studies have shown that children with autism focus on inanimate and irrelevant details of interactive situations while missing the relevant social cues, e.g., neglecting the eyes and mouths of protagonists (Klin et al., 2002). Another study asked children to sort people who varied in terms of age, sex, facial expressions of emotion and the hat that they were wearing (Weeks and Hobson, 1987). In contrast to typical children who grouped pictures by emotional expressions, the participants with autism grouped the people by the type of hat they were wearing. Generally, they prefer to attend to inanimate objects over other humans (Klin et al., 2003; Jones et al., 2008). Furthermore, while imitation and co-movement serves as a major instrument for early affect attunement and social cognition, several studies have found that autistic children do not readily imitate the actions of others (Smith and Bryson, 1994; Hobson and Lee, 1999).

As a result of these deficiencies, there is a general lack of the embodied or kinaesthetic empathy that normally mediates the affective perception of the other. The feedback cycles of mutual incorporation are not achieved; instead, for children with autism the others remain rather mysterious, detached objects whose behavior is troublesome to predict. According to embodied and enactive approaches, what these children primarily lack is not a theoretical concept of others’ minds (Klin et al., 2003; Gallagher, 2004; De Jaegher, 2013). This is supported by the fact many autistic symptoms such as lack of emotional contact, anxiety or agitation are already present in the first years of life, i.e., long before the supposed age of 4–5 years to acquire a Theory of Mind. Much rather, high-functioning autistic persons often develop precisely an explicit “Theory of Mind” approach to emotions, i.e., they learn to infer or “figure out” what emotion the other is experiencing (Grandin, 1995).

EMBODIED THERAPIES

Our model of embodied affectivity can be elucidating for the interpersonal processes taking place on a non-verbal level in psychotherapy and for the explicit thematization of bodily experience in body psychotherapy and dance movement therapy. These approaches use non-verbal modalities to start change processes, to gain access to affect and memories that dominated in a former situation—actualizations that are important, for example, in trauma treatment (Caldwell, 2012; Eberhard-Kaechele, 2012). Embodied therapies are increasingly framed in non-linear causality, enactive, ecological and dynamic systems approaches (cf. Koch and Fishman, 2011), to account for the complexity of motor processes and their interwovenness with brain functions and sociocultural/environmental factors.

The embodied affectivity model allows us to locate disorders on the continuum of e-motion and affectivity and to plan embodied interventions accordingly. Anxiety (1) for example, can be addressed and be alleviated by engagement in low intensity and gradual swaying movements—particularly with advancing movement in the horizontal plane—which are part of many meditative circle dances (Koch, 2011), strengthening their ability to calm down and perceive their environment as less threatening. Depression (2) can be temporarily alleviated by moving into high arousal, high intensity, abrupt movements with round reversals (such as in jogging or dancing) particularly in the vertical plane...
(Koch et al., 2007) which awakens joy and vitality, and decreases negative affect. Persons affected from Parkinson (3) profit from Tango Argentino (Duncan and Earhart, 2012)—characterized by its mostly low intensity abrupt movements and turns with flow adjustment, which address initiation, balance and gait, but also intersubjective sensitivity—and from expressive dance training, which strengthens their expressive abilities. Alexithymia (4) is common in both somatoform and autistic populations. Somatoform patients benefit from structured authentic movement interventions (The Body Mind Approach (TBMA), Payne and Stott, 2010) including a partner exchange, which support the connections between feeling and verbalization; and autists (5) from mirroring in movement—including structured authentic movement—, which can improve their intersubjective abilities (Koch et al., 2014b). This mostly evidence-based literature on the effects of movement therapy on psycho-pathological conditions has been summarized in Koch et al. (2014a).

Dance movement therapy starts on the moving and e-motion side (e.g., Levy, 2005), whereas embodied therapies such as focusing (Gendlin, 1967) and functional relaxation (Fuchs, 1997) start on the sensing and affectivity side of the model. Most experienced body psychotherapists—no matter which background they work from—integrate both sides in a balance of sensing and moving (e.g., Lahmann et al., 2010; Caldwell, 2012). A focus on breathing can help find the basis of this balance (e.g., Williams et al., 2007). Rogers (1951) already pointed out that persons entering into a sensing, reflective, and affective mode during the process of therapy, pausing and giving room to integrate the bodily feedback into the progression of a therapeutic session, are the ones that profit most from psychotherapy. Damasio (1994, 1996), in his somatic marker hypothesis, specified that no decision of practical relevance can produce authentic results without interoceptive and proprioceptive feedback from the body. Embodied therapies can help the individual to access this somatic information and to take it into account for daily living—a step that becomes increasingly difficult for many persons in Western societies with their largely exteroceptive focus.

CONCLUSION

In sum, emotions result from the body’s own feedback and the circular interaction between affective affordances in the environment and the subject’s bodily resonance, be it in the form of sensations, postures, expressive movements, or movement tendencies. Through its resonance, the body functions as a medium of emotional perception.

Our account places particular emphasis on the intersubjective dimension of affectivity. In interaffectivity, our body is tacitly affected by the other’s expression, and we experience the kinetics and intensity of his emotions through our own bodily kinaesthesis and sensation. This means that in every social encounter, two cycles of embodied affectivity become intertwined, thus continuously modifying each partner’s affective affordances and resonance. Infant research demonstrates how the mutual bodily resonance of facial, gestural and vocal expression engenders our primary affective attunement to others. From birth on, the body is embodied in intercorporality, and thus becomes the medium of interaffectivity. Hence, affects are not enclosed in an inner mental sphere to be deciphered from outside, but come into existence, change and circulate between self and other in the interbodily dialog. Emotions are neither individual nor unidirectional phenomena; they operate in cycles that can involve multiple people in processes of mutual influence and bonding. These processes of embodied interaffectivity as well as their disturbances are of major importance for psychiatry, psychosomatics, and psychotherapeutic interactions and can be addressed in embodied therapies.

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APPENDIX

BODY SELF-EFFICACY-SCALE (BSE; KOCH, UNPUBLISHED MANUSCRIPT)

Please answer how the following statements apply to you on a scale from 0 to 5 with 0 representing “applies not at all” and 5 representing “applies exactly”:

1. I can move well. 0 1 2 3 4 5
2. My movements are beautiful. 0 1 2 3 4 5
3. My body is flexible. 0 1 2 3 4 5
4. I have many bodily constraints. 0 1 2 3 4 5
5. My body is lifeless and inert/numb. 0 1 2 3 4 5
6. I can easily jump over an obstacle of medium size. 0 1 2 3 4 5
7. My body feels like “in pieces.” 0 1 2 3 4 5
8. My body often feels like it does not belong to me. 0 1 2 3 4 5
9. I can move elegantly/with grace. 0 1 2 3 4 5
10. I can express myself in movement. 0 1 2 3 4 5

Internal Consistency BSE: Cronbach’s alpha = 0.75 (students; n = 63) and 0.83 (patients; n = 83) on the German version.

EMBODIED INTERSUBJECTIVITY SCALE (EIS; KOCH, UNPUBLISHED MANUSCRIPT)

Please think about the last situation in which you have moved with others in a group (e.g., in movement therapy, in dancing). In how far did the following statements apply to you on a scale from 0 to 5 with 0 representing “applies not at all” and 5 representing “applies exactly”:

1. I can pick up the movements of others. 0 1 2 3 4 5
2. Through movement I can transmit/communicate aspects of myself. 0 1 2 3 4 5
3. Through the movement of others, I realize how they feel (e.g., joy, tension). 0 1 2 3 4 5
4. I can accompany others in movement (“mirror” movement). 0 1 2 3 4 5
5. I can recognize how others feel through joint movement. 0 1 2 3 4 5
6. Through joint movement a connectedness arises. 0 1 2 3 4 5
7. If others move in synch with me, I feel accepted by them. 0 1 2 3 4 5
8. Something new can emerge in moving with others. 0 1 2 3 4 5
9. I can understand, what others want to express with movement. 0 1 2 3 4 5
10. If another person moves in synch with me I feel understood. 0 1 2 3 4 5

Internal Consistency EIS: Cronbach’s alpha = 0.87 (students; n = 63) and 0.90 (patients; n = 83) on the German version.

Both measures had been pretested in a longer version on a sample of 80 psychology students at the University of Heidelberg and had been cut down from an item pool of twice the amount of items using the criterion of internal consistency scores. Both, the BSE and the EIS, were then tested with a sample of 63 students of therapy sciences at SRH University of Heidelberg, resulting in a Cronbach’s alpha (BSE) of 0.75; and a Cronbach’s alpha (EIS) of 0.87 (Kelbel, unpublished thesis). They were further employed in the context an RCT on movement therapy with schizophrenic and autistic populations (n = 83; 42 schizophrenic patients and 41 Autism Spectrum Disorder, mostly high functioning) and were found reliable for these patient groups (Cronbach’s alpha BSE = 0.83; Cronbach’s alpha EIS = 0.90; Kelbel, unpublished thesis).

The BSE (of both student and patient sample data) was validated with the Ryckman Scale (Ryckman et al., 1982) a standardized questionnaire on perceived physical ability. The two scales showed a correlation of \( r = 0.55, p < 0.01 \), indicating high agreement, even though, Ryckman et al. did not cover the aesthetic aspects included in the BSE.
3 The Invisible Interface

WT Terminology

“Wearable technology” (WT), the blanket term used here, has various meanings. The original term was “wearable computing,” which started with Edward O. Thorp and Claude Shannon’s pocket-sized analog computer developed in 1966 to predict results in Las Vegas roulette games. Since then this term, shortened within the technology community to “wearables,” has applied to generations of wearable computers as well as to other mobile devices right up through the iPhone.1 “Wearables,” of course, in the wider culture means (or used to mean) simply clothing, so the use of the term to refer specifically to wearable computers is evidence of how technological language impacts common speech.

In addition, the term “WearComp” (initially coined by Steve Mann) or, more broadly, “wearcomp” bears a relationship to “ubicomp”—the short form for “ubiquitous computing” (also known as “pervasive computing”), also in common use.2 In line with ubiquitous computing’s technology-driven environment, wearcomp aims at augmenting or empowering the user in some way, either by enhancing her perceptual reality or access to knowledge or by enhancing her physically. Early wearable computers were not actually worn, they were carried or held, or placed out of sight in pockets or installed in shoes, and ultimately have little to do with the bodily display that is the nature of dressing. Where wearable computing is actually wearable (and visible on the body), it appears as a technological prosthetic—as demonstrated by the members of the MIT Borg Lab. But pocket-sized or prosthetic, wearable computing suppresses the body in favor of the mind or intellect, or the body itself is comprehended as biometric data. Wearable computing is generally not conceptualized in the contexts of dress; instead it favors positivist wearable systems that ignore clothes’ cultural connotations and seek the pure functionality of the invisible body. This is a theme common in sci-fi literature, as in the polycarbon suit in William Gibson’s influential 1984 novel Neuromancer, a garment that appears to erase the body altogether.3 In the end, most wearable computing accords with modernist, masculinist views that subordinate the physical body.4
Terms that do signify dress are many, including “smart clothes,” “fashionable technology,” and “fashionable wearables,” terms that, as we have seen, got their start in the late 1990s, when technology and fashion drew upon ideas in popular culture. In 1995, when Alex Pentland began collaborating with the Paris Créapole to create the Pompidou show, the project was termed “smart wear.” Later, Sabine Seymour, who claims authorship of the term “fashionable technology,” uses it in a general way, encompassing everything from wearable systems to smart textiles. She writes that she is concerned with “designed garments, accessories, or jewelry that combine aesthetics and style with functional technology.” Related nomenclature revolves around the idea of “embedded technologies,” the actual circuitry or devices worked into a garment or fabric, for example, “electronic textiles,” “e-textiles,” or “techno-textiles”—all meaning roughly the same thing. With her background in art making, set design, and feminist art, Maggie Orth first brought to the MIT Media Lab ideas about flexible or woven circuitry and conductive fabrics. In 2000 Woodrow Barfield and Thomas Caudell, in their comprehensive anthology *Fundamentals of Wearable Computers and Augmented Reality*, put forward the term “computational clothing” to refer to “clothing that has the ability to process, store, retrieve, and send information,” but this term did not achieve wide circulation.

The umbrella term “wearable technology” circulates throughout the discourses of these fields in a general way that can seem contradictory or confusing. Sometimes it refers to devices that are actually worn, and sometimes not (as with pocket-held devices). It can apply to work that is, in the end, functional in application and potentially commercial in distribution. But at the other end of the spectrum are works that are experimental and conceptual in nature and aid awareness of embodiment. They may be based on research that could eventually have functional applications, but they exist as artworks or creative designs that have noncommercial or primarily conceptual content. Circulating in art, fashion, and academic systems, they are often seen or performed at workshops and conferences of professional societies, but sometimes they are found in art galleries and museums. I call this work “critical WT,” or “critical dress,” and it will be discussed in chapter 5.

**Personal Affective Computing**

A field entangled with WT is “affective computing” or “affective wearables,” which developed from the larger domain of ubiquitous computing (ubicomp), initiated in the late 1980s by Mark Weiser. Weiser’s fundamental principle was technology’s drive to disappear. In a talk given at Xerox PARC in 1994 he said, “Good technology is invisible . . . ubiquitous computing is about ‘invisible’ computing.” To Weiser, the term “interface” inferred a boundary, something to be eliminated. Weiser envisioned ubicomp as the opposite of virtual reality. He imagined it would become a
natural and empowered way to deal with the everyday realities around us, to release us from the stresses of information technology overload and calm us down.\textsuperscript{10} Weiser was a thoughtful techno-scientist, but his untimely death in 1999 prevented the evolution of his ideas and any reassessments he might have made as technologies advanced.

Rosalind Picard, a computer engineer from Georgia Tech, joined the MIT Media Lab in 1991, when she began working with search and retrieval tools for digital images and video. Later she oversaw Steve Mann’s graduate research (his “photographer’s assistant” project). Also at MIT she formed a new working group based on the concept of affective computing, a term she coined. The idea, based on the fundamentals of ubicomp, was that computers need to be able to read and respond to the emotions of their users. Ironically, her view of the body as a source of emotions advances the idea of the body as manipulable text or data. Picard explains affective computing as “computing that relates to, arises from, or deliberately influences emotions.” Computers that read our emotions and/or simulate having them are within her purview; however, Picard explicitly does not address “how people feel about their computers, and how and why their feelings evolve as they do.”\textsuperscript{11} Picard’s theory and subsequent research served to entrench this view of the body as code or data, especially in military and medical applications.

Affective wearables do not merely augment the wearer; they also deal specifically with human emotional states, and often deal with them proactively. A 1997 paper by Picard and wearable computing grad student Jennifer Healey, titled “Affective Wearables” (given at the first ISWC conference), described a wearable system, built at MIT with the help of Thad Starner, that focused not on input and retrieval of images and data in the wearer’s environment, or what is accessed through digital media (Internet and email), but rather on sensing the wearer’s autonomic biosystems. Called the Startlecam, it consisted of a wearable camera, worn as a piece of jewelry around the neck, that continuously recorded images. Small electrodes attached to the wearer’s hand or foot measured skin conductivity, and pattern recognition software was programmed to recognize the wearer’s “startle response,” “a skin conductivity pattern that occurs when the wearer feels startled by a surprising event.” In other words, Picard and Healy wrote, when the wearer is extremely affected by something she sees, a response is detected. The triggering images picked up by the camera could be saved and/or sent to be analyzed by friends and family, enabling action (like contacting the police) if the wearer were to be, for example, threatened in some way. “StartleCam is an example where analysis of a wearer’s affective patterns triggers actions in real time.”\textsuperscript{12} The authors also experimented with an “affective CD player” that read bodily indicators of emotion and then played an appropriate piece of music, supporting a light mood or ministering to an unhappy one, because, as they wrote, “Music is perhaps the most popular and socially accepted form of mood manipulation.”\textsuperscript{13} This
mention of what might be socially acceptable is the only indication in the article that there could be any concerns about psychological or social control mechanisms. In fact, there is some discussion of how to create a personal-area network that would wirelessly connect sensors, processors, and other devices located in the wearer’s shoes and jewelry, making them inconspicuous or, in fact, invisible.

Picard’s book *Affective Computing*, also published in 1997, has a short chapter entitled “Potential Concerns.” Some of these concerns are ones “we will likely never encounter,” like the fictional computer HAL in *2001: A Space Odyssey* and other “famous computers and robots who have run amuck,” in part because of their affective functions—they do not work well and the computer misunderstands or badly imitates human emotions. These, Picard writes, are technologically improbable, at least in the foreseeable future. Among her more serious concerns is the potential for affective computers to mislead people and engender mistrust—software agents might be programmed to appear sincere but to lie, for example. Moreover, in cases where a computer might (in the future, say) have emotions itself, should it be allowed to direct them toward a human? Or if a computer can sense our moods, how is it supposed to act? (Picard cites the Happy Vertical People Transporter from Douglas Adams’s *The Restaurant at the End of the Universe*, 1980, which tried to cheer everyone up but only made them happy when it broke.) In Picard’s view, “If a software agent found its user feeling down and out while cruising on the net one night, it should not engage in juvenile responses such as spewing forth ‘Cheer up!’ messages, or worse, selling the user’s name to advertisers who might bombard her with slogans such as ‘Drink Pepsi’ to feel better.” Instead, she proposes, it should point its user toward other people to chat with, or find some distracting news item. In other words, it should be cunning and effective. Picard acknowledges the potential problem of privacy, as computers gather increasing amounts of data about our emotional states, but she suggests this is only a problem if we begin to feel out of control. She assures us that alarmist scenarios of overt political or centralized emotion control are far-fetched (although fifteen years down the road, we are now encountering these very issues in the wake of leaks and whistleblowing concerning government surveillance).

In the end, *Affective Computing* does not really address the idea of manipulation, or consider how people might become subjectified by computers that control information about our personal behaviors and are programmed to exploit such data. In the chapter on affective wearables, Picard indicates how jewelry and clothing, being relatively unobtrusive in our daily lives, can effectively gather information about our habits and reactions to stimuli. Adjacent to our skin, they have perfect access to our pulse and sweat glands. Such biometric items, like Starner’s and Mann’s more ungainly wearables, would be “always on,” but so unobtrusive as not to interfere with the wearer in any way. They could collect unprecedented amounts of information, not just about our behaviors but about our emotions.
Affective computing grew out of the interest in wearable computers and the expanding capabilities of technologies like sensors that measure simple bodily processes. Although wearable computers began with the intent of personal empowerment—to win at gambling, for example, or to store and process larger amounts of information than ordinary memory can handle, or to access online communications—research and development focused increasingly on an interpretation of augmentation that transfers agency to the computational system. In a 1997 paper entitled “Augmented Reality through Wearable Computing,” the authors (a collaboration including Picard and Starner) surveyed the field at that time and identified what they saw as its long-term goal: “to model the user’s actions, anticipate his or her needs, and perform a seamless interaction between the virtual and physical environments.” In affective computing it is the computer, not the human “host,” that is aware: reading physiological data (biometrics), making decisions, responding to external conditions. “Aware” or “context-aware” intelligent wearable computers conduct an increasing array of medical, field, and office labor, and have many leisure and lifestyle applications. But the focus of these applications, the human wearer, is represented by default as unaware and so, ultimately, as a regulated or mediated subject.

**Affective Computing and Emotional Awareness**

Recent directions in cognitive science emphasize embodied emotion and experience as existing in opposition to cybernetic, mind-centered theories. Antonio Damasio’s work is useful in reconsidering how emotion might apply to wearable technologies. In his book *Descartes’ Error* he points out that, far from a Cartesian mind or self existing at the core of, and in opposition to, the body, the mind—and any sense of self we might fleetingly possess—is an interplay of processes distributed throughout the body. Indeed, Picard cites Damasio’s ideas about embodied emotions, but she does so in the context of a discussion of how computers, not humans, might have them.

In Damasio’s later book, *The Feeling of What Happens* (published after Picard’s *Affective Computing*), he focuses on the importance of emotions for consciousness. He says we propagate emotions intentionally by surrounding ourselves (and, I would add, adorning ourselves) with things we emotionally respond to, and we do this because emotions are bound up with our ability to think, imagine, and even reason. Emotions are bodily functions in humans that foster higher thought processes. Damasio contends that emotions are not exceptional states—rather, we are always having them. Furthermore, this experience is a complex, distributed, and constantly changing form of behavior. He bolsters his arguments with research done on patients with brain damage that can be located physically through brain-mapping techniques. Significantly, Damasio distinguishes between emotion and feeling: the first is a collection of...
responses that form a pattern. Emotions come in many forms, not all of which are publicly displayed. The second, the feeling, is the private, mental experience of an emotion. “We can feel our emotions consistently and we know we feel them . . . [they are] part of a functional continuum.”

Emotions are impossible to enumerate—there is no finite list of primary emotions, in Damasio’s view—although he thinks that certain broad categories can be distinguished, because they involve different locations in the brain and different chemical conditions in the body. Furthermore, beyond having an emotion and feeling it, we know we feel it. “Feeling feelings,” as Damasio calls it, involves a second order of representation necessary for core consciousness, and it is of extraordinary value in the orchestration of survival. “Emotions are useful in themselves,” Damasio says, “but the process of feeling begins to alert the organism to the problem that emotion has to solve.” It might be fair to speculate, then, that any mediation in the circuit of having emotions and feeling them—any system that administers to the physical emotions before we can mentally process them—might create problems.

In her book Materializing New Media, Anna Munster criticizes Damasio’s approach to emotional embodiment as one that nonetheless instrumentalizes the body in the manner of affective discourse: for Munster, feeling feelings might be expressed in the phrase, “the feeling that one is in the mapping of one’s self”—an affectivity “produced in relation to the body rendered as information.” Perhaps so, and perhaps the instrumentalization of the body is so internalized in scientific discourse that it cannot be avoided. Nevertheless, Damasio’s view offers a dynamic encoding of mind-body experience that is not static and cannot be predicted. His notion of “feeling feelings” is a process expressed in performance works by artist Riitta Ikonen, who creates nontechnological garments that demonstrate felt emotions like anger, emotions that arise from specific physical sources in the everyday, like being overheated on subways—or perhaps rage at nothing we can name. These garments are presented in staged photographs, but Ikonen imagines that they might be worn experimentally in the real world, so the wearer tests the impact of the garment, on herself and others, as a way of both inducing feeling and contemplating exaggerated levels of emotion.

The Disappearing Body

Numerous writers, including N. Katherine Hayles and Barbara Wegenstein, have shown how technology’s virtualization of the body has become part of the discourse of posthumanism. They have portrayed postmodern subjectivity as an ongoing action that, as Munster writes, feeds into a “system of disembodied optics.” It refers to a habit of thinking that began with Descartes. In the wake of cybernetic theory and the advance of informatics, emotions became part of a lost corporeality. The implications of this have permeated our culture, especially our notions about the body.
Figure 3.1
Linkages between emotion and dress have rarely been investigated in cultural history and theory, which have only begun to critically investigate the realm of fashion. Joanne Entwistle suggests that this omission is due to the persistence of notions about the body as textual or as acted upon by culture, exemplified by Marcel Mauss’s “Techniques of the Body” and Foucault’s notion of “technologies of the body,” both of which presume bodies, and consequently embodied subjects, that are constructed by external social regimes. In *How We Became Posthuman* Hayles ascribes the progress of disembodiment to Foucault, who described the body as a play of discourse beholden to semiological structures. Accordingly, Entwistle argues that “Foucault’s work may contribute to a sociology of the body as discursively constituted but is limited by its inattention to the lived body and its practices, and to the body as the site of the ‘self.’”

Hayles quotes Elizabeth Grosz, who summarizes more broadly “that the mind/body split, pervasive in the Western tradition, is so bound up with philosophical thinking that philosophy literally cannot conceive of itself as having a body.”

New-media theorists have addressed the body, but usually as a mediated phenomenon. In his book *New Philosophy for New Media*, Mark Hansen bemoans the virtualization of the body expressed by twentieth-century cybernetic theory. He combines ideas from Henri Bergson, Walter Benjamin, and Gilles Deleuze to argue for embodied affectivity at work in digital media art, but his argument for recorporealization is hampered by his focus on virtual and screen-based forms. In *Getting under the Skin* Bernadette Wegenstein treats phenomena from popular culture and feminist performance art to argue that the body has taken on the characteristics of a medium: mediality is the new corporeality. For media theorist Lev Manovich, however, the phenomenon he calls the “externalization of the mind,” a process in which technologies objectify reasoning and control or augment it, goes back at least to Francis Galton. Manovich maintains that an “assumption of isomorphism” between “the mental process of reasoning and the external, technologically generated visual forms has haunted us at least since the end of the nineteenth century.”

In a similar if more historically abstract vein, Paul Virilio writes about the fading of the physical with the rise of motors and cinematic machines. One figure that Virilio sees as representing this process is the late nineteenth-century photographer Étienne-Jules Marey, who specially clad his subjects to achieve his special effects: “The whiteness of birds or that of horses, the brilliant strips pasted on the clothes of the experimental subject, make the body disappear in favor of an instantaneous blend of givens under the indirect light of motors and other propagators of the real . . . the aesthetics of disappearance renews the enterprise of appearance.”

Virilio’s other figure, from the early twentieth century, is the reclusive Howard Hughes:

Hughes was already aping our future, the abandonment of the vehicular speed of bodies for the strangely impressive one of light vectors, the internment of bodies no longer in the cinematic
cell of travel but in a cell outside of time, which would be an electronic terminal where we’d leave it up to the instruments to organize our most intimate vital rhythms, without ever changing position ourselves, the authority of electronic automism reducing our will to zero.34

Similarly, in his *War in the Age of Intelligent Machines*, Manuel De Landa writes about the military push “to get humans out of the decision-making loop,” to create a machinic phylum capable of ever more efficient armies and (ultimately) systems of government that approach the sci-fi-sounding dystopia of the “computational society.”35

Italian philosopher Giorgio Agamben brings up the ethics of affective technologies in his essay “Identity without the Person,” in which he cites the ongoing proliferation of biometric technologies, such as optical scanning to obtain fingerprints and iris patterns, and notes that in Europe a biometric identity card is making an appearance (in fact, the *Carte nationale d’identité sécurisée*, or CNIS, has been put in place in France as a noncompulsory identity document since his book was published). Indeed, there is movement toward creating digital archives of DNA to implement systems of managing health and security. This goes beyond the mining of our online activities by companies like Google and Facebook for continual commercial expansion; it treats our very physical beings as data.36 Agamben asks, “What kind of identity can one construct on the basis of data that is merely biological?” He goes on: “If, in the final analysis, my identity is now determined by biological facts—that in no way depend on my will, and over which I have no control—then the construction of something like a personal ethics becomes problematic. . . . How can I take on, and also take distance from, such facts?”37 Agamben characterizes the situation we face in terms that hark back to the Freudian uncanny:

Following the rule that stipulates that history never returns to a lost state, we must be prepared . . . for that new figure of the human. Or, perhaps, what we must search for is simply the figure of the living being, for that face beyond the mask just as much as it is beyond the biometric *facies*. We still do not manage to see this figure, but the presentiment of it suddenly startles us in our bewilderment as in our dreams, in our unconsciousness as in our lucidity.38

**Invisibility and Modernist Dressing**

WT rehearses an age-old dialogue between society and the body that proposes a process of invisibility based on an ideal of pure functionality and pure information, and ultimately a uniformity of dress. Historically, the technological view of wearable computing is anti-dress and essentially modernist in its cultural viewpoint, in accordance with traditional science. The idea that clothing must be minimized, standardized, and muted reflects a tendency known among fashion historians as “functional anti-fashion.” That tendency maintains there is a neutral or natural way to dress, or even that
Figure 3.2
Vladimir Tatlin’s New Way of Life worker’s clothing, 1924.
it is most natural to dispense with dress altogether. “Not fabric but skin” became the mantra.\textsuperscript{39} Functional anti-fashion ignores clothes’ cultural connotations and seeks a simplicity that harks back to early twentieth-century modernist prototypes, such as Vladimir Tatlin’s unisex worker’s clothing. Moreover, as Radu Stern points out, nearly all modernist utopias—from Thomas More’s imaginary island (\textit{Utopia}, 1516) to Aleksandr Bogdanov’s sci-fi novel \textit{Red Star} (1908, about a socialist society on Mars), George Orwell’s \textit{Nineteen Eighty-Four} (1949), and even Mao Zedong’s Chinese Cultural Revolution (beginning in 1966)—envision functional universal dress, often blocky suits or overalls with little or no difference between individuals.\textsuperscript{40}

The perfect technological translation of this sartorial purism might be Susumu Tachi’s Invisibility Cloak (2004), a prototype employing a real-time video feed and an external projector. Designed as active camouflage for medical and military applications, the Invisibility Cloak is more like a “cloaking device,” echoing episodes of \textit{Star Trek} as well as William Gibson’s \textit{Neuromancer}.\textsuperscript{41} A trope of the modernist body, Gibson’s mimetic polycarbon suit is heir to Philip K. Dick’s camouflaging “scramble suits” in his 1974 novel \textit{A Scanner Darkly}. Such a suit revives an older fantasy of the Invisible Man, popularized in H. G. Wells’s 1897 novella of that name (as well as by the 1933

\begin{figure}[h]
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\caption{Susumu Tachi, Invisibility Cloak, 2004. Courtesy of Susumu Tachi and Tachi Laboratory, University of Kyoto.}
\end{figure}
movie version), in which the protagonist, a scientist named Griffin, theorizes and
carries out a procedure that changes his body’s refractive index to that of the ambient
air, so that his body cannot reflect light. It is another instance of the reductivist myth
about the visual body.42

That myth is also a perennial one because of its superhuman promise of stealth
advantages in intelligence and military operations. Protective camouflage, of course,
exists in the animal world. Passive camouflage—fabrics printed with textures matching
combat environments—was widely used in World War I. The importance of camou-
flage was underlined by the development of precision optics for airborne observers,
telescopy, and photography, and massive research on camouflage was undertaken
during World War II.43 Recent work in active camouflage technologies, which adapt
as the user moves around, like Tachi’s cloak, also includes research with battery-
powered, flexible organic light-emitting diodes (OLEDs). Several wearables design
teams are exploring metamaterials, surfaces that can deflect radio or light waves so
that they pass around the object, rendering it invisible.44
Almost simultaneously with Tachi’s and other researchers’ work toward active camouflage, corresponding effects turned up on fashion runways: British designers Viktor & Rolf’s A/W 2002–2003 collection utilized blue-screen (chromakeyed) fabrics throughout. In what might be called a satire of techno-invisibility, as the models passed the audience the fabric of the clothes streamed with video of traffic, clouds, and other moving images, so that the models tended to partially disappear. From the fundamental metaphor, grounded in Cartesian thought, that the invisible body is the corollary of reason, or mind, follows the judgment of the negative value of dress that is equally fundamental in Western culture, a judgment that witty designers seize upon and upend with their ironic designs.

But a body unclothed is not a body erased. In his essay “Nudity,” Giorgio Agamben says the unclothed body is always, in our culture, inseparable from a “theological signature.” Everyone is familiar with the story of Genesis and the origin of clothing. Agamben recounts that Adam and Eve in Paradise wore not nothing but “clothing of grace” (in some versions called “clothing of light”), of which they were denuded or stripped and forced to cover themselves with sewn fig leaves (Genesis 3:7) and, later, garments fashioned from animal skins. So it is the brief, self-aware nakedness—or the binary state naked/clothed—that signifies sin. In later accounts, the animal-skin clothes are symbols of death. And nudity itself is, in fact, what is identified with fallible human nature. So the unknowable, unseeable garments of Paradise, Adam and Eve’s dress before the Fall, become a theological model for a perfect garment that clads being but covers nothing (bad), a kind of magical anti-fashion distinguishing the divine. Medieval adaptations of the garments of Paradise occurred in folklore, in tales of magical creatures like fairies who have the ability to cover themselves with fern cloaks or Tarnkappen. Conversely, according to Agamben, material clothing emerged with the sinful (erotic) body, and shares its curse in an unending dialectic that propels our conflicted attitudes toward dress and our modern condition as inevitable creatures of fashion.

**Augmenting the Invisible Body**

In terms of dress, two related, reductivist notions about the body pertain here. First, that the body (complete with its emotions) can be understood as invisible data or be reducible to data, and second, that communication between persons and machines, or between posthuman “persons,” can be seamless, instantaneous, and without physical mediation. The latter idea is viewed by Lone Koeford Hansen as the modernist dream of telepresence, or ideal communication, rooted in a long-range project that included, in the late nineteenth century, widespread interest in mental telepathy, a concept that emerged alongside the exploitation of electricity and the discovery of radio waves, providing a context for the notion of “thought waves” as acceptable
According to Hansen and others, even the writings of Sigmund Freud contributed to this popular belief: his theories about communication between the conscious and the unconscious challenged traditional beliefs about the relations between the brain and the body.

Invisibility, then, could be said to exist on two levels: the invisibility of the body itself (in a theological state of grace or a technological state of data) and the invisibility of ubiquitous and wearable personal and affective technologies that read, tag, and track bodies in the social sphere. As Eric Kluitenberg writes, “The assimilation of computer technology in the environment introduces a new issue: the problem of invisibility. When technology becomes invisible, it disappears from people’s awareness,” making it difficult to discuss or even to react to its presence.

In the late 1990s, after the dot-com bubble burst, fashion, as an arena for seasonal innovation and cyclical marketing, became less committed to embedded technologies in general, and particularly so in the United States. This contributed to a slowdown in industrially funded wearables research. In her book Picard does not consider what the economics of a world of wearable affective computing would be, though efficient and beautiful affective wearables would surely be expensive investments for their owners. And while there are many individuals who will pay any price for fashion, the
idea of wearing the same wired-up necklace and bracelet configuration day in and day out flies in the face of how dress actually operates, how by its very nature it changes and evolves, and we with it.

The research situation was somewhat less austere in Europe. The project of adapting high-cost electronics to existing habits of dress was undertaken by the 1999–2000 collaboration between Belgian menswear designer Walter van Beirendonck and the Belgian research initiative Starlab to create i-Wear. They produced a testing ground for the application of ideal communication and affective computing processes in real-world apparel design, with the electronic components modularized in such a way as to overcome the divergent economic trajectories of fashion and technology.

As a wearables line i-Wear was based on situating individual system modules within multiple layers of traditional clothing (which might appear as a series of shirts all worn at once, as in figure 3.5). For example, there could be a memory layer, an energy supply layer, a motion-sensing layer, and a storage layer. Aside from the energy layer, others were optional and “modular.” On its website i-Wear announced, “The team has developed a wireless communication system, the Fabric Area Network (FAN), to enable networking of sensors and data, [allowing] communication between various layers (at very short distances), without danger of radiation to the body.” These layers talked to each other, and certain functions, like accessing the Internet, were initiated by voice command—at least in the project plan. Other functions would require no conscious user interface whatever, functions like learning the wearer’s schedule and issuing prompts to leave for the airport, or compiling advertising for services in the vicinity of a department store. The clothes might even guide a wearer to a geographic destination by heating up to indicate the right track or going cold to signal the wrong way. Since traditional clothing elements were used (albeit in an unusual way), the technology was doubly invisible, first because it was out of sight, hidden in fabric, and second because the use of standardized clothing items was itself unremarkable (yet oddly fashionable, as in the attraction of redundant collars and lapels). Unfortunately, i-Wear was short-lived; the project went bankrupt within a year.

**Wearables and ANT**

The dynamics of communication are at the heart of the factors that Ana Viseu found problematic in her case study of technology in the workplace. In 2002 she studied Bell Canada field technicians who participated in a three-week wearable-computer pilot program involving the Panasonic CF-07, a scaled-down computer made wearable by means of a shoulder bag and customizations, some fashioned by the workers themselves. In the study the computers handled dispatch, communications, and all logs of work done in the field, and the field technicians were to wear them all the time. The technicians therefore did not have to take orders from a dispatcher and had
considerably more information about each job, the components and procedures involved, and its context than they normally would have had. These were seen by the company as the advantages that wearable computers were offering—in other words, they were billed as enhancing the agency of the workers. On the other hand, the technicians who wore the computers reported, at the end of the study, feeling less in charge. They could only input information in prescribed fields with no spaces for notes explaining details of a job, for example, and no ability to correct their work later, and they felt removed from the actual presence of their overseers. In other words, they perceived their sense of agency, of being able to control what they were doing, as reduced. In fact, the workers experienced a critical change in their very identity. To them, CF-07 became a millstone and an embarrassment. Even worse, it was originally planned to include head-mounted displays, which in the end were only employed at the outset of the project and in the publicity campaign surrounding it. Images of the HMDs used in promotional materials made Bell Canada seem like a futuristic company, and project directors often alluded to Star Trek or Robocop, and spoke of “cutting-edge technology” in interviews. But the technicians were averse to going out into the field wearing them. Even without the HMD, just wearing the computer in its sling tended to alter the self-perceptions of the technicians. They began employing derogative terms for the equipment, like “Mickey Mouse stuff.” Beyond its good or bad functioning as equipment or tool, the CF-07 functioned as personal display in a social context, display that marked its wearer as having lost a degree of dignity and self-command.

Viseu uses the study to critique actor-network theory (ANT), a dominant method of analysis in the domain of science and technology studies. ANT considers humans and computers as equal agents in a dynamic system of relationships. According to Bruno Latour, a pioneer of ANT, society should not be considered “a special domain, a specific realm, or a particular sort of thing, but only as a very peculiar movement of re-association and reassembling.” ANT is not a unified theory but rather a set of ideas based on the writings of contributors like Latour, Michel Callon, and John Law. ANT poses a critique of traditional social theory that assumes distinctions between nature, society, and their artifacts. Latour argues that modernity relies upon the “complete separation between the natural world (constructed, nevertheless, by man) and the social world (sustained, nevertheless, by things).” In reality, according to Latour, humans and nonhumans function as equal partners—equal actors—in social networks, and the stability of each actor’s role must be negotiated and locked in position inside the network. It is a relational situation. In the Bell Canada study Viseu argues that, in real life, the nature of the actors was not so clear cut. “This project was not ultimately successful in creating a stable actor-network of augmented field technicians, hybrid entities of body and machine.” Part of this failure lies in the facts that (1) the field technicians proceeded from an already stable ANT (their relationships to their existing materials and technologies) and (2) the wearable transformed the body in ways that
The Invisible Interface

The system had not anticipated. For Viseu, “One of the main tenets of ANT is the presumed symmetry between the social and the technical.” But this symmetry is not always upheld in specific cases involving humans and technologies in direct physical relationships. In fact, a fundamental asymmetry persists insofar as devices on our bodies give us certain ideas or make us feel particular ways about ourselves, without any equivalent self-awareness on the part of the devices.

Besides actor-network theory, another way of considering any WT is to think of it as a dynamic of the interface, or an “interfaciality,” as Anna Munster calls it. She argues that the interface provides machines with, literally, a “face,” though of course she is talking about screen-based interaction (the screen as a natural face is discussed by a number of authors including Jacques Lacan). Munster applies Deleuze and Guattari’s concepts of “facialization” (poles of smooth versus striated, surface versus depth—a dynamic assemblage of subjectivization) to the “faces” of users and digital technologies.

The major achievement of interfaciality is not so much in escaping the face but rather multiplying it. We increasingly find ourselves running the gamut of a slippery middle ground, bouncing back and forth between the surfaces of new technologies and those of our own skin. What we need, then, is a way to rethink this area in terms other than those offered to us by the intermediary positioning of the interface between two opponents: the human and the inhuman machine. For from this position, one side will always be required to conjoin with or eradicate the other.

In other words, the interface, which strives to be invisible, shows an “other” face that tends to erase our own.

Of course, Munster’s interfacial “area” (the screen) collapses in the case of wearables. Here the “surfaces of new technologies and those of our own skin” are in contact and, as with the cultural perception of wearing clothing, identified as one, yet with multiple sensations of inside versus outside, look versus touch. The mechanics of faciality are distributed throughout our bodies. As Deleuze and Guattari point out, the face’s “white wall/black hole” system extends to the body, a vehicle for its discipline: “The difference between our uniforms and clothes and primitive paintings and garb is that the former effect a facialization of the body, with buttons for black holes against the white wall of the material.” They say, “The face is a politics.” It is a “faciality machine because it is the social production of face, because it performs the facialization of the entire body and all its surroundings.” Wearable computers do the same. The screen (face) still exists, but its “body” extends across ours, morphing machinic personalities in multiple ways. In this case, the body might be a battleground. In the Bell Canada scenario, for example, the technicians interacted with the technology on their bodies, their distributed and wearable interface, but that interface was unstable and generated, in effect, multiple “faces”—multiple agendas and demeanors—among which the users erratically bounced.
Ana Viseu itemizes the categories of wearables research as follows: health, to monitor the body; work, to improve efficiency and productivity; military/security, to enhance physical and cognitive abilities; and leisure/lifestyle applications. While the MIT Media Lab worked creatively on all those fronts, speculating on multiple applications for their inventions and methodologies (such as affective computing), Philips, in the private sector, set about developing specific industrial prototypes. In 1995 Philips Design, a branch of Koninklijke Philips Electronics, initiated its Vision of the Future project to “propose ideas and solutions that will enhance people’s lives.” The project used standard design methodologies starting with creative, multidisciplinary workshops to identify user needs and technology forecasts and ending with presentation strategies that included website videos and design exhibitions to garner feedback. A large part of the research was devoted to wearables. According to the 1999 account by CEO Stefano Marzano, who uses the expansive language of utopianist technology we have already encountered, Philips was responding to “the goal of our species” to be omnipresent, omnipotent, and omniscient. Moreover, he writes, “We don’t want to be bogged down by material encumbrances”: “What people really want . . . is to be free of any attachments. We don’t want to bother with tools at all. We don’t want to fly in an aircraft, we want to fly like a bird. We don’t want to sit in a car in a traffic jam, we want to be beamed around by the transporter in Star Trek.” Marzano proposes that Philips Design move beyond miniaturization to “progressive integration.” He proposes clothing as an important locus for our technologies, as it is the least of human encumbrances—but he suggests that the fashion industry must be transformed so that clothing design is no longer simply a choice of colors and styles, but a choice of functions. “The technology industry will have to learn how to deal with fashion” and think emotionally. At least until the “ultimate step” can be accomplished: functional applications incorporated directly into our bodies.

An outcome of Philips’s Vision of the Future initiative was a book entitled New Nomads (2000), intended to publicize the company’s exploratory research in wearables design. The concept of “nomads” is never discussed, oddly enough, but clearly relates to Marzano’s concern for physical encumbrances. It also reflects a broader discourse that began to appear in wearables research, concerning an ideal user who would be young, mobile, and, presumably, tech-savvy. This user type, projected as the one most likely to want to use, or already be using, computers and mobile phones, was being targeted by market research among companies developing mobile telephony in particular: the “young, urban nomad.” Accordingly, Philips’s New Nomads reads like the product of corporate workshopping. It begins with sweeping claims about culture and lifestyle, organized into catch-phrases, or “scripts,” like the Mosaic Society, the Explorer Society, the Caring Society,
and the Sustainable Society. In fact, the problem the team set for itself (in the late 1990s) was based on the fact that portable devices like phones and PDAs were inefficient (Starner’s earlier argument) and hindered the nomadic lifestyle. Philips aimed for an “installed base of electronic clothes.”

As phones and other devices become modular, we will move from a situation where we own one phone to a situation where we have many phones integrated into garments. By modularizing the product we can separate the “brain” from the other components. The “phone” module will be no more than a button that simply plugs into the clothes that are already equipped with an infrastructure to support it.66

In a telling turn of phrase, the text says that clothing would be explored as new “interface real estate,” a term that conjures up hard-core images of financial speculation.67 Acknowledging the example already set by MIT Media Lab research in wearable computers and e-textiles, the text of New Nomads recounts the assembly of multidisciplinary collaborations between designers, engineers, and “non-technical” students and academics in fields like animation, writing, industrial design, and business. This process resulted in a Philips research team comprised of a fashion designer (Nancy Tilbury), an industrial design engineer, and an electronics engineer, plus additional experts once the project got started, who convened at Philips’s labs at Redhill, Surrey, in the United Kingdom. Ultimately the group produced prototypes that claimed a strong expressive agenda, attire that would reflect “the ritual of dress—how people assembled their personal identities through clothes that combined the functionalities of protection, thermal insulation, waterproofing, etc., with the personal and cultural qualities of aesthetic and identity.”68 This representation of dress as ritual pays lip service to the social phenomenon of dress while interpreting it primarily as a technical challenge to fulfill physical needs that in some vague and ancillary way add up to “aesthetic and identity”—whatever either term is taken to mean, which is not discussed. Likewise, the “cultural qualities” of dress, cited in the statement, are not examined.

The Redhill team concluded that five categories of clothing best reflect the needs of those they consider potential early adopters of digital clothing, the “new nomads”: (1) digital suits for business professionals, (2) electronic sportswear, (3) children’s clothes, (4) wired streetwear for youth, and (5) a category called “enhanced body care and adornment,” encompassing a “new age” approach to clothing that makes the wearer feel good. Most designs are based on the body-area network concept, with conductive textile components and assorted modular devices. The New Nomads business suit, for example, a traditional men’s dark suit, is enhanced specifically for professional networking in a competitive work environment (prescient, since social media sites like LinkedIn were just a few years away). The jacket has a sleeve flap that uncovers an embroidered keypad (similar to Maggie Orth’s design) and a limited flexible
display, with a separate small phone earpiece and speaker device—essentially the suit is what it was billed to be: a mobile phone. The power source is not discussed. A similar suit is envisioned for an “air hostess,” only the embroidered keypad is replaced with a specialized flexible PDA on the sleeve with full digital display including a diagram of cabin seating. Philips suggests the adaptability of the suit type for numerous work environments.

The section on electronic sportswear is the largest, and features a jogging suit whose functionality includes wireless connections to a digital audio player. A “virtual coach” monitors and regulates the pace of physical performance with verbal commands. Another design, a high-performance workout ensemble, features full biometric sensing and digital music access. Several designs for wearable gear for extreme sports like mountaineering or snowboarding include similar devices along with a GPS monitor and, in the case of snowboarding, a proximity sensor on the back of the jacket (with warning light) to help the athlete avoid collisions (those from behind, anyway), and motion detectors that modify the digital music selections to complement the rhythms of the athlete’s body.

Children’s interactive clothing designs consist of rather large coats with fabric antennas, radio tagging, and miniature remote-controlled cameras to track a child’s whereabouts. The coats have flexible sleeve panels displaying interactive games in which they and their playmates are iconized as animal or monster avatars that run around in sync with their wearers, creating a playful online network. Wired streetwear for youth, on the other hand, proffers fanciful versions of rave attire. An outfit called the Queen of Clubs is a skimpy workout ensemble with added texture and detail that interacts with the club lighting controls. A single wearer might affect the overall environment, so perhaps the garment is designed for professional dancers. A DJ’s outfit called In the Mix consists of denim jacket and pants in baggy, clubwear style (of the late 1990s), with remote sampling capability that allows the DJ to leave the turntables and move among the audience. In an addition, separate small devices such as a phone, an audio system, and PDA modules can be “buttoned” into the system and accessed through a flexible interface patch. The streetwear section also includes a winter parka (Surround Sound Audio Jacket) with a “smart pocket” that connects its digital audio player to the interface with a jack plug. A flash loader for audio memory is integrated into the sleeve, accepting cards in a connecting Velcro-flap pocket. The hood, equipped with headphones, inhibits unwanted ambient noise, and an electroluminescent display on the back of the jacket, called Electrophonique, emits patterns in response to the frequencies of the music being played.

Perhaps the most well known of the New Nomads designs involve the category of body care and adornment. The example called Feels Good is a cream kimono made of a synthetic sheepskin type of fabric, with woven panels of conductive thread down the back and sleeves. A pocket device disseminates electrostatic charges, creating a
Figure 3.6
tingling sensation designed to relax the wearer. The outfit becomes a wearable leisure
drug, but the experience is under control. Biometric sensors in the kimono monitor
the degree of relaxation of the wearer, and adjust automatically. The overall effect of
the long kimono, worn by a skinheaded model over an embroidered Japanese skirt, or
*hakama*, is exotic and evokes martial-arts culture and extreme fashion trends like skirts
for men—the Feels Good kimono outfit recalls several launchings of fashionable men’s
skirts in the late 1980s, most notably by Jean Paul Gaultier.70

The body care and adornment category also includes a Micro-Climate sweatshirt
containing an embedded audio system, with speakers inside the hood and a volume
control over one ear. The hood also contains an electronic mask to filter out urban
and industrial pollutants, oddly prefiguring the biofiltering masks that would become
common in Asian cities during the early 2000s, a response to SARS and bird-flu scares.

The New Nomads prototypes, which were photographed for elaborate spreads in
Philips’s publication, like MIT’s “Beauty and the Bits” designs, were partly functional
and partly aspirational, but based on research that was under way.71 A few of the
designs incorporated feedback systems to monitor the wearer’s location or health and
drew on existing GPS and medical sensing technologies. But there is a controlling
ambition behind the project: that all our needs or wants might be anticipated if only
the right technology can be found, if only the right combination of application and

*Figure 3.7
Figure 3.8
garment can be determined, that will absolutely modernize our habits of wearing clothes and allow Philips to commandeer this new market for dress.

Moreover, Philips’s approach to WT, while trying to address the problem of technology cost by breaking the systems down into modular units, never comes to terms with the nature of dressing. Only extended wear and a wide market for such items could mitigate the cost, a formula that flies in the face of the way we actually interact with clothing: continually donning and shedding, reconfiguring pieces and moving on. Dress without change becomes uniform, and indeed the Philips Nomads wearables are activated or signaled by symbols akin to the insignias of uniforms, or computer desktop icons, or designer logos. The “body as desktop” image adapts the body to the technology, the opposite of what Philips’s Marzano claimed their project sought to do, and the emphasis on “nomads” is reduced to a sporty professionalism, a professionalism with a new wardrobe but professionalism nonetheless, so that the emphasis on the functionality of clothes promotes not nomadic freedom but the body at work, a socially productive body, one that might act but is ultimately acted upon.

About the same time as the New Nomads designs were being developed, Philips collaborated with American denim company Levi Strauss to create the ICD jacket, designed in part by Italian garment engineer Massimo Osti, with specially constructed pockets for electronic devices like a cell phone and MP3 player. The resulting product, the ICD+, was an elaborate item custom-designed for the portable electronics that came with it (all for about $900 in 2000). But the jacket was not in itself WT in any sense. Nor was it original as garment design—it compared to many gear-oriented, rugged outerwear jackets from North Face or other sports apparel brands. Moreover, garments with pockets designed for technological devices were already on the market. “Technology-enabled” vests, for example, by Scott Jordan for SCOTTEVEST appeared at the same time and were highly popular (and cheaper, since the user loaded it with her own electronics). But the ICD+ project received an enormous amount of media attention after being launched by its two global corporations. Publicity featured trendy descriptions like “smart” and “intelligent,” not really accurate for the project but terms that nevertheless became attached to it. Despite the media blitz, ICD+ was ultimately a commercial failure. But it was the first item launched that tried to capture the public imagination and accomplish what New Nomads predicted, to appear chic and hip to “early adopters” and “young urban nomads” and try to alter their conception of dress.

Response and Display (Skin Probes)

Since women have traditionally been culturally positioned as objects for display, they are more likely than men to be represented as clothes-conscious and more likely to be portrayed as emotional (though these stereotypes are slowly changing). Thus women
have been frequent subjects for emotion-sensing devices. An example from 1970s popular culture was the mood ring, a piece of jewelry made of thermochromic material and marketed mostly to women. The mood ring epitomized the notion of a “faciality machine” (a face on the body), as it claimed to indicate the wearer’s level of excitation to onlookers. The same notion—the feminine body as the generator of mindless emotions available for display and marketing—tended to persist in affective computing-based WT efforts.

In a similar vein, in 2004 Lisa Stead and her collaborators at Central Saint Martins College of Art and Design developed a computing platform, known as AffectiveWare, to create clothing incorporating personalized display, “an emotion wardrobe.” They proposed garments that connect internal sensing and external display (through LEDs sewn into the fabric). These would be programmed beforehand to respond to epidermal conditions using emotional templates created by measuring the sensors’ responses to actresses simulating emotional states. Eight such emotional states were specified, in accordance with psychologist Robert Plutchik’s somewhat outdated, mid-twentieth-century categorization of primary human emotions. The wearer could control aspects of the display within certain predetermined limits, but this was not essential for the system to function. The project was sophisticated, but was still rooted in the notions that clothes are enhancements to visual and emotional subjectivity, and that emotions are categorizable autonomic responses that can be encoded as data.

Since New Nomads, corporate designers have envisioned works that index the body in much the same way as the mood ring or AffectiveWare but are much more advanced. In 2006 Philips premiered their Design Probes program under Clive van Heerden, a cluster of “far-future” research initiatives “that aim at identifying long-term systemic shifts and anticipating future lifestyles.” Probes initiatives have explored housing, food (diagnostic kitchen, multisensory gastronomy, and home farming), dress, jewelry, and tattoos. Best known is their SKIN research initiative linking skin surface and light emission through biometric sensing technology. SKIN: Dresses, designed in collaboration between Nancy Tilbury, Lucy McRae (who calls herself a “body architect”), and Rachel Wingfield, are pure prototypes, impractical and photogenic, garnering extensive media coverage, which was their main purpose. The project won the Red Dot Design Award in 2007 (a prestigious corporate design competition held annually by the Red Dot Design Museum in Essen, Germany). Images of the dresses were made available as high-resolution downloads on the Philips website and subsequently went viral on countless news posts, other websites, and blogs. Notably, one of the dresses appears on the cover of Sabine Seymour’s book Fashionable Technology. SKIN: Dresses were positioned for distribution by social media and were for several years among the best-known images of WT in existence—the perfect Internet spectacle.

Moreover, in true modernist, utopianist style, they are not dresses at all, but are, as their name implies, second skins, typical anti-fashion, or “invisible clothes,” clothes
Figure 3.9
designed for response and display. Their visual appeal makes them (and their wearers) objects to be looked at, skins that show. The SKIN: Dress called Frisson is little more than the familiar bodysuit—a catsuit—with an attached structure of long copper antennae surrounding the upper body that react like gooseflesh. The ends of the antennae light up (via LEDs) when brushed or blown on, a phantasmic representation of a normal skin response to sudden movement or temperature change. Bubelle, a homophone of “bubble,” is a frothy, light cage around the body. Actually, it is made of two layers, with a “slip” (undergarment) equipped with heart-rate and galvanic skin-response sensors that project LEDs onto the surface of the outer skin/screen. Thus the dress simulates a blush, a coloration of human skin—specifically the face—in response to emotion or anxiety. Both Frisson and Bubelle “digitize” physical responses of the human skin and display them in spectacular, facialized form. As Philips says in its press material, the two outfits “have been developed as part of SKIN to identify a new way of communicating with those around us by using garments as proxies to convey deep feelings that are difficult to express in words”—another way of saying that our native responses are too illegible. Lone Koefoed Hansen suggests that Philips’s concept “implies a split between mind and body,” a split that the garment miraculously mends: “Philips Design has ended up equating the wearer’s body to a computer in which the flow between input and output is a matter of cause and effect. . . . While the dresses are permeated by hypermediacy (they display technology as fashion), they also embody the dream of ultimate communication transparency.”

As interplay of information and media, Bubelle does what Gibson’s polycarbon suit or Tachi’s Invisibility Cloak do, render the body invisible altogether, only in Bubelle’s case the body not only loses its own visibility but becomes a spectacular vision of brand marketing, the surface (the bubble) as face. As Anna Munster interprets Deleuze and Guattari, “Facialization is a system of codifying bodies according to a centralized conception of subjectivity or agency in which the face, literally or metaphorically, is the conduit for signifying, expressing, and organizing the entire body. In human-technology interactions, the generation of the agency of face tends to erase the living body and suggest the immediacy of communication ‘face-to-face.’” In the case of Bubelle, it is a lovely, machinic face that forms a brilliant cover for a particular subjectivization, one dominated by industry and commerce.

In 2008 Philips released their SKIN probe Fractals, digital jewelry or scarf arrangements that propose to be a hybrid between clothing and jewelry. Fractals sense bodily changes as well as the proximity of other bodies and react with pulsing LED configurations. Philips explains, “Traditional LED lighting can be cold and uninviting but Fractal uses materials to diffuse, focus and filter the light, giving a warmer, soothing lighting experience.” The goal here was not to use textiles or apparel assembly methods at all, but to look forward to a replacement for garments “in the year 2020.” The publication of Fractals arrayed on nude female models in poses familiar to fashion
Figure 3.10
photography suggests the context into which Fractals were projected, one of business and marketing. In 2009, in another Philips research initiative, designer Paul Lemmens created a prototype for a unisex Emotions Jacket. Looking like a typical athletic jacket on the outside, it is wired to intensify the physical effects of emotions in the setting of the movie theater, coordinating with the narrative onscreen. When the hero is fighting for her life, the wearer-viewer feels a pulsation that simulates a rapid heartbeat. Here the emotions are imposed and directly commercialized, and are designed, ultimately, to help sell movies.  

**Therapeutic Dress**

The discourse of WT as industrial research and commercial prototype follows the rhetoric of fashion, as we have seen with Philips (the use of models, photography, hype, allusions to a better life, etc.), but with a particular emphasis on the psychology of the “new” or the “future.” French philosopher Gilles Lipovetsky discusses the changing appeal of newness, especially in fashion. Rather than being a commitment to modernism, the choice of something new has taken on the implication of “doing something, becoming different, . . . getting off to a fresh start. ’Make me over’: as fashion ceases to be a directive and uniform phenomenon, the purchase of fashion items is not governed by social and aesthetic considerations alone, it has become a therapeutic phenomenon.”  

Moreover, Lipovetsky writes, the rise of media technologies has led people to pay more attention to themselves and their bodies, to react to the flood of information by actively managing their appearance and health. However, the situation has also brought about Deleuze’s control society, in which individuals are not only monitored but trained—perpetually trained and challenged but never finished with anything; a kind of control that modulates and molds individuality in an ongoing, never-satisfied manner. In control society, attention to the body never reaches its goal.

Jenny Tillotson is a researcher in the field of aroma and medical applications of clothing for health and well-being, an area she calls Scentsory Design. She too is interested in a garment that creates a second skin, one that communicates not just visual signals but olfactory ones—a “main line to the brain,” as she says. Like all ubicomp researchers, she contextualizes her WT in futuristic narratives, or “science fashion.” Influenced by Picard’s affective theories, Tillotson brings an extensive background in the technology of scent and scent delivery to the futurist promise that WT will improve our lives in order to create what she calls “emotional fashion,” explained as “responsive clothes integrated with wireless sensor networks that offer social and therapeutic value in a desirable fashion context.”

Scentsory Design’s 2003–2005 silk organza dress both diagnoses and cures. This therapeutic garment, by Tillotson and designer Adeline André, uses nanotechnology
Figure 3.11
and microfluidics to sense the wearer’s body heat and other indicators of stress; the garment then provides aromas that boost the limbic system in the brain, our emotional center. Like Philips’s Design Probes, Tillotson’s garments are conceived as a “smart second skin”:

Clothing (and jewelry) become almost living as if copying the human skin, our senses and circulation system. A micro pump is integrated within the design which represents the “heart,” micro tubes represent the “veins and arteries” and various biosensors mimic the senses to create a new interactive fabric communication system in clothing. . . . Fragrances are actively “pulsed” electronically through a micro cabling system in the fabric web.99

Additionally, the system can administer deodorant, which is triggered by a sensor and delivered in response to human sweat. According to the website, when we smell certain scents around our bodies, not only our emotions but our body chemistry changes. The Smart Second Skin prototype can alter mood, encourage sleep or energize action, increase self-esteem, and stimulate the imagination.90 The result is an antidepressive form of embodiment that interprets self-expression as an involuntary emotional condition that is instantly addressed by the system. The wearer can control the scents, or the system can do it for her. But self-therapy here, as with Philips’s Feels Good kimono, trains the body to receive administration and accept emotional manipulation. Tillotson has also designed jewelry based on the behavior of insects—a “bombardier beetle” (the kind that squirts predators with hot fluids), which forms a neck ornament and releases scents to a wearer, and a “spider” necklace, which contains sensors that read its wearer’s humidity levels and wirelessly signals the beetle to release scent and aromatically “communicate” with oneself, or with another wearer in an aromatic network. The pieces are expressive and fascinating but incorporate the same principles of affective control.

Wearable affective computing—the idea of using wearables to read and index our emotions—continues to drive research in ways that reveal attitudes toward the body. In 2010 Paul Brokenshire, Azmina Karimi, and April Pierce at Simon Fraser University initiated a long-term project to sense and visualize human emotion. Their initial prototype jacket, called Heart on Sleeve, does not read emotions at all but represents them. The jacket senses and distinguishes various kinds of touch—for example, a gentle embrace or a blow cause differently colored lights and pulsations to be initiated on the wearer’s sleeve, signaling the level of contact. Here the body is underestimated: “One of the concepts we explore is the unawareness of being touched.” Heart on Sleeve purports to let not just the wearer but onlookers know about the quality of physical contact.91

More unsettling is Rachel Zuanon and Geraldo Lima’s wearable video game interface, NeuroBodyGame (2010), which allows users to play games using their brain signals. The authors quote Mark Weiser’s writings in their discussion of the project:
Figure 3.12
they say they are using ubiquitous computing as a “method of enhancing computer use by making [the computer] effectively invisible to the user.” But the game actually creates a convergence of ubiquitous technology and virtual reality (which Weiser felt were opposite goals). Here the wearable is not conceived for fashion but purely to heighten engagement with the game. Using galvanic skin response sensors and blood volume pulse sensors, the vest sends these signals directly to the game system, which adjusts itself accordingly, responding moment by moment to the electrophysiological data from the user. As a result, the game gets slightly easier if anxiety runs too high, or increases in intensity if the user seems too calm. In addition, the vest displays the user’s degree of nervous tension in blue, green, red, and yellow lights, and will even administer a soft back vibration, a calming massage, if the system senses extreme tension during play. It is all intended to enhance the user’s immersive experience of the game, so that it seems to respond to her unconscious desires.

The piece can be compared with Philips’s Emotions Jacket. The garments function differently, rendering cinematic action tactile in Philips’s piece and incorporating
biometric data in NeuroBodyGame. However, both seek to enhance the user experience of a commercial media product, ultimately removing distinctions between the inside and outside of the user’s body, or between subjective experiences and the effects of a media simulacrum.

Wearable Technologies and Bare Life

In *Affective Computing*, Rosalind Picard writes, “Perhaps the most ominous scenario with any digital information is that of some powerful centralized organization using the data in a pernicious way.” She says such concerns conjure up Huxley’s *Brave New World* (1932) and are not unimaginable, since in reality people are given medications like tranquilizers every day without their consent. Picard’s explanations of why this is not a major threat are not compelling: according to her, healthy people remain in control of their lives (begging the question of who is to be considered healthy), and in any case controlling, or even recognizing, all of our emotions is too complex a task for current (as of 1997) technology. It was a shortsighted argument. Ultimately Picard, like Mark Weiser, subscribes to a benevolent conception of technology that seeks to do good: “George Orwell’s powerful image of ‘Big Brother’ is largely political, antithetical to the image of affective computing as a personal technology.”
Monitoring and manipulating bodily processes like emotions is not right or wrong by degrees (which senses can be monitored, how much, how often), but must be thought through in terms of a larger context. Instead, too often, biometrics is granted a state of exception on the assumption that technology has nothing to do with politics. Picard’s influential model of affective computing simply does not consider its operation as part of larger systems of behavior and organization—as part of a larger biopolitics, to use Foucault’s term. According to Alexander Galloway and Eugene Thacker, “The methodology of biopolitics is therefore informatics, but a use of informatics in a way that reconfigures biology as an information resource. In contemporary biopolitics, the body is a database, and informatics is the search engine.” Galloway and Thacker refer to Giorgio Agamben’s manipulable body. Agamben has written about how power works to reduce the individual human to “bare life,” for which he uses the ancient Roman term for the disenfranchised citizen, *homo sacer*. “Bare life” is the physical and technical, but not the political or spiritual, condition of life—it is life insofar as it can be measured and counted. Accordingly, the absent or invisible body is a cultural trope for the posthuman subject as biopolitical organism.
A project called Intimacies, by the V2_Lab at the Institute for Unstable Media in Rotterdam, is an example of research in wearables that provides a fashionable portrait of a biopolitical organism and portrays the intricacies of body-technology disappearances. It is a collaboration between V2’s designers and Studio Roosegaarde (Daan Roosegaarde). Sometimes called an installation and shown as such, it consists of two dresses (Intimacy White, 2009; and Intimacy Black, 2010) utilizing e-foil, a commercially produced polymer-dispersed liquid crystal, layered between plastic, which reacts to an electrical charge by varying the intensity of light. The dresses contain infrared sensors and microcontrollers that activate the e-foil in reaction to human proximity and transform the material from nearly or completely opaque to transparent, depending on the distance from other dresses. According to the V2 website, Intimacy White, designed by Maartje Dijkstra, acts as “an emotional meter that measures and makes visible the level of transparency, disclosure, and thus intimacy experienced by the user/wearer in social interaction.” Studio Roosegaarde explains, “Social interactions determine the garments’ level of transparency, creating a sensual play of disclosure.” In the case of Intimacy Black, designed by Anouk Wipprecht, the dress was actually programmed to react biometrically, changing with the rate of normal breathing at
moderate proximity, and accelerating to the pace of a heartbeat as another human body approaches closely.

The dresses are also aspirational as contemporary fashion. Cyberpunk author Bruce Sterling, in his *Wired* magazine-affiliated blog entitled *Beyond the Beyond*, commented on the Intimacy project: “Interesting to see Dutch wearables designers getting dresses to do more of what dresses do (be provocative) as opposed to getting dresses to do more of what computers do (blink and beep a lot).” In fact, the Intimacy dresses make an interesting comparison with Philips’s translucent, bubble-shaped Bubelle dress from about three years earlier. Both are portrayed as a second skin, or face, by taking on the qualities of skinlike blushing. Both aim to be highly photogenic and to be presented in the context of high fashion, with sartorial details like defined waists, halter necklines, and cutaway hemlines.

In 2011 Studio Roosegaarde released a new set of dresses under the title Intimacy 2.0. These dresses update the earlier designs, making them even more understandable in a contemporary fashion context (there is more traditional dress material, mostly leather, and less overall nakedness), and they have a direct biometric component: the dresses monitor the wearer’s heartbeat, which in turn controls the transparency of the e-foil material on each garment. In addition, Studio Roosegaarde extended the project by issuing a call to haute couture designers to collaborate on new versions of the Intimacy collection.

In the end, the dresses seem to equate intimacy with the naked body, giving us the very image of disappearing dress. The level of nudity recalls both Agamben’s evocation of the gauzy garments of Paradise and Teague’s Nearly Nude dress in the 1939 *Vogue* “Fashions of the Future” spread, both abstractions symbolizing visions of corporeal perfection: one theological, the other technological. But for the Intimacy projects, the modernist reference is a ruse. Rather than predicting perfection, as the eugenics touted by *Vogue*’s designers sought to do, these invisible dresses reveal our failure, or at least our discomfort, with proximate bodies and with dress that undresses us. And they do so in terms of technology that virtualizes, codes, and even manipulates our intimate fears.
A deep shift in Western culture has occurred in the last 200 years. We have moved from lifestyles in which work, play, and other forms of experience are inextricably intertwined, to one in which most people separate their work life from a private (and often less societally valued) life of fun and play. Engineering has played a central role in this bifurcation, fulfilling a cultural desire to engineer human experience for optimal functionality. The result has been a great increase in our material comforts, coupled with a harried, frenzied lifestyle for many. In this chapter, I will argue that designing systems to support rich, meaningful, and pleasurable human experiences requires moving away from the model of engineering experience and towards an interdisciplinary approach to computing, in which technology design is intertwined with philosophical and cultural analysis.

1. **FUN IS THE DREGS OF ENGINEERING EXPERIENCE**

The history of the industrial revolution is a story of the gradual optimization and rationalization of work. Over the last two centuries, work has gone from an integral part of daily life, to something which is bought and sold per hour and engaged in in standardized ways. Craftspeople were collected into factories, their work was split into pieces along a production line, some steps of the production line were taken over by machines, and gradually craftspeople became tenders of rote machinery, engaged in soulless work.

This shift is epitomized by the work of the efficiency expert Frederick Winslow Taylor, who in the early 20th century developed the system of scientific management or ‘Taylorism.’ Taylorist engineers maximize the efficiency of human labour by observing workers, analyzing their movements, and developing a script for the ‘one best way’ to achieve their work tasks, in the process eliminating all unnecessary or wasteful motions. After the development of the assembly line, which rationalized and optimized machine labour in the production process, the last source of inefficiency in factories was human labour. Businessmen were naturally eager to find ways to reduce this inefficiency, a task which Taylorism solved.

After Taylorist analysis, a worker is told not only the steps to take in order to fulfill a task, but also what order to do those steps in and exactly how to move in order to minimize waste in their work. Because of the mindless, rote nature of Taylorized work, the quality of experience of work is reduced. Rote labour causes both repetitive stress injuries and rebellious, unhappy workers. Offsetting this reduction in experience is a drastic increase in its efficiency and productivity. Because of these great increases in efficiency, Taylorism took the business world by storm. The impact of Taylorism on Western, especially American, culture can hardly be underestimated. It is still felt through later, less extreme manifestations such as ergonomics and time management. Despite the problems of Taylorism, many of us have remained with a model of work in which experience is engineered for maximum efficiency and minimum pleasure. We have also imported these models to the home: to-do lists, appointment calendars, and a clutter of chores regiment our home lives and attempt to ensure that we are as efficient at home as we are at work.

Engineering work leads to a bifurcation of experience. As Blythe and Hassenzahl argue in this volume, if work, on the one hand, maximizes efficiency at the cost of pleasure, we balance out in our free time by engaging in *fun*: maximizing pleasure and minimizing task achievement. Many of us spend 8-10 hour days working efficiently and unhappily, then race home for a mindless evening in front of the TV or Playstation. In the post-industrial West, and especially in America, we have split experience into two: whereas life could be a steady stream of work intermingled with pleasure, we have disengaged the two, often preferring to lavish ‘serious’ attention only on the first.

2. **COMPUTER SCIENCE IS COMPUTATIONAL TAYLORISM (BUT DOESN’T NEED TO BE)**

A similar split and imbalance has occurred in computer science. Taylorism is, at heart, simply engineering applied to human behavior; hence it is no surprise that computer scientists tend to approach work processes the same way as a Taylorist.
We break complex processes down into simple steps, we figure out optimal procedures for each work step, and we eliminate wasteful steps and problems.

This process is most clearly seen in Artificial Intelligence, in which both classical planning and the newer behavior-based approaches attempt to engineer experience by increasing the efficiency and optimality of algorithms and to maximize their functionality (Sengers 1998, Sengers forthcoming). But we see similar emphases in human-computer interaction (HCI). On the one hand, it has a strong emphasis on work-related tasks and increasing the efficiency of their execution. On the other hand, it often focuses on rationalized and optimized techniques to understand and engineer human experience – even when the goal is fun.

Engineering is the correct approach to take when there is a well-defined task to be solved. But designing systems that open a space for new kinds of experience is not an engineering task per se. Instead, one must consider the technical challenges to be overcome in the context of the kinds of cultural and social meaning that the system may take on and the ways in which users may choose to interact with it. This necessitates a shift from a pure, task-oriented engineering approach to an interdisciplinary approach that combines socially-oriented approaches such as the social sciences or literary and cultural studies with more traditional human-computer interaction and computer science. Such hybrid approaches are becoming popular both within HCI and in the media art community (see e.g. (Ehn 1998), (Wilson 2002)).

3. THINK BEYOND BOTH WORK AND FUN

The pendulum between work and play is beginning to swing in the other direction. The recent interest in ‘fun’ as manifested by this volume is important in opening up an understanding of some of the unstated work-related assumptions underlying HCI methods. Funology will necessitate fundamental rethinking of some HCI approaches and the development of new techniques that are less about efficiency and more about quality of experience.

Nevertheless, funology is not enough. Rather than continuing the bifurcation of experience into work vs. play (traditional HCI vs. funology), as a culture we need to consider systems that take a more integrative approach to experience. This may mean on the one hand systems like that of Hohl, Wissman and Burger in this volume that combine work-related task achievement with pleasurable experience. More fundamentally, it also means that we need to explore the vast and utterly neglected territory of possible systems that are really neither work nor fun. Such systems may support reflection by users on their lives and activities; they may give users new ways to experience the world; they may make cultural comments in the form of interactive artworks. These systems are neither directly task-related, nor intended simply to entertain. They have a serious point, but they may bring their point across in a playful manner. Examples of such work include Bill Gaver and Heather Martin’s conceptual information appliances (Gaver and Martin 2000), which explore the role of technology in our everyday lives; Tony Dunne and Fiona Raby’s electronic furniture (Dunne and Raby 2001), which provide people with different ways to sense and respond to activity in the electromagnetic spectrum; and Simon Penny’s Petit Mal (Penny 2000), an artwork exploring the nature of artificial agents through a gangly and not very bright robot whose complex and graceful physical activity is almost entirely triggered by human bodily interaction. What these systems have in common is not a desire to engineer experience, but to build thoughtful artifacts that create opportunities for thinking about and engaging in new kinds of experiences. We need to shift from engineering experiences – whether work or fun – to designing them, using principles that draw on both technology design methods and social and cultural analysis.

4. SOME EXPERIENCES DESIGNING EXPERIENCES

In this section, I will describe some experiences in designing systems that are intended to support richer and more meaningful notions of human experience than those traditionally used in computer science by using a broader, interdisciplinary approach combining computer science with cultural analysis. My first work in this area was in designing Artificial Intelligence (AI) architectures for interactive computer characters. Traditionally, AI focuses on activity in the world as problem-solving rationality. The goal for autonomous agents is often to behave optimally rationally in approaching some goal. For interactive computer characters, this focus is problematic, since characters do not need to be particularly smart or rational, instead needing to project emotion and personality in a way that is understandable to users. In the Industrial Graveyard (Figure 1), I explored how to create agents, not as rational problem-solvers, but as experienced by human users (Sengers 1999). Users observe the antics of a discarded lamp in a junkyard, while controlling the behavior of its unsympathetic overseer. The technology is based on narrative psychology, which argues that humans interpret activity by organizing it into narrative. I support human interpretation of character action by providing visible cues for narrative interpretation of agent behavior, most notably through transitions between behaviors that connect them by expressing the reason for the behavior change to the user.
With the Industrial Graveyard, I started out being interested in how human experience was represented in agents; but in the course of building the system, I began to realize that what was central was the way in which the user experienced the system. The next system I worked on explored ways to generate engaging user experiences. With a team of 5 researchers led by Simon Penny, I explored the construction of physical experiences in virtual reality (Penny et al. 2001). In Traces, users’ body movements generate 3-dimensional traces which share their physical space, and with which they can interact (Figure 2).

In traditional VR systems, the body is an afterthought, left behind when the headset is put on. The goal of Traces was to develop a kind of VR installation where it is possible instead to have strong bodily experiences. Traces is an installation for the CAVE VR display, a small room onto whose walls 3D images are projected. When users enter wearing 3D glasses, they have the illusion of being surrounded by virtual objects in real, physical space, while they can still look down and see their own bodies. In Traces, vision cameras detect the movement of users, allowing them to leave behind and interact with traces of physical movements that seem to surround them (Figure 3). Gradually, the traces become more autonomous, turning into “Chinese dragons” which flock together and sense and react to users’ physical movements (Figure 4).
Figure 3: A user (body model shown in black) moving through Traces leaves behind tracks of physical movement (gray). In the CAVE the voxel model is not shown; instead, the user’s own body leaves behind colourful 3-dimensional traces in the space surrounding him or her. Users are surrounded by the trace they create.

Figure 4: A user (body model shown in black) being chased by a set of Chinese dragons (grey). In the actual experience in the CAVE, the user does not see their voxel model, but only sees Chinese dragons sharing their physical space and responding directly to their physical movement.

Traces was installed at Ars Electronica ’99, where users leapt, ran, skipped, did cartwheels, and came out of the CAVE sweating. Users had strong reactions to the Chinese dragons; though the dragons were not particularly intelligent, they seemed strongly alive and present to human users because they shared the same physical space. With Traces, it became clear that physical interaction and shared physical space with (embodied) users is a way to create meaningful, powerful experiences.

The Influencing Machine (Sengers et al. 2002) explores the human experience of affective computing, or computational systems that recognize, reason about, or can express emotions. It was developed by the author, Rainer Liesendahl, Werner Magar, and Christoph Seibert at the MARS Exploratory Media Lab as part of the EU SAFIRA project. In the Influencing Machine installation, users enter a small room, on one wall of which childlike drawings are being created in real-time, accompanied by an abstract soundscape. In the middle of the room, they discover a wooden mailbox, into which they can put art or colored postcards. By choosing postcards, they can change the “mood” of the drawings and sounds as they are being created. Users explore the postcards, asking themselves what the picture means to them, and exploring what it means to the machine. With the Influencing Machine, we came up with ways to engineer enigmatic experience: the interaction is deliberately open-ended and open to interpretation, yet through the interaction of postcards, graphics, and sound, we can create experiences which have concrete meaning for many users. The Influencing Machine was formally evaluated by Gerd Andersson, Pia Mårtensson, and Kristina Höök, who developed new techniques for non-task-oriented evaluation for this
project, most notably by using groups of users and recording their conversations in order to better understand the nature of user experience of the system.

Figure 5: Input and output of the Influencing Machine

These three systems are all examples of critical technical practices (Agre 1997), or practices of technology development which incorporate a cultural, critical component. In all three cases, we built on an analysis of what was missing in the cultural assumptions about human experience that were unconsciously built into previous technology. The Industrial Graveyard twists the notions of optimality, correctness, and action-selection inherent in many algorithms for autonomous agents. Traces alters the assumption of bodilessness behind many VR applications. The Influencing Machine plays off of the assumption in many affective interfaces that “affect” is something to be extracted through surveillance or skin contact, and instead places the user’s own choices at the center of affective interaction. I believe building rich, meaningful experiences will require not just engineering competence but also cultural analysis, design, and art perspectives.

5. HOW TO DESIGN EXPERIENCE

A pure engineering approach suggests that one can understand human experience by building formal models of it – the traditional approach taken by computer science. In AI, for example, we build conceptual models of people, implement these in code, and run them, in the hopes of better understanding what human experience is like. In HCI, we similarly often build cognitive models of users, allowing software to reason about what users may be experiencing by comparing their behavior with expectations of human behavior built into the cognitive models. In many ways these attempts to make human experience computational mimic the efforts of the Taylorists, as we try to clean up, formalize, and organize what is an inherently messy and perhaps fundamentally incomprehensible phenomenon. In my own work as an AI researcher, I became frustrated by the fact that my clean, beautiful models of behavior always seem to miss the point – they can somehow never generate the complexity and richness of natural behavior of humans or animals.

The perspectives of the arts and humanities also suggest the futility of trying to formally represent experience. Many humanists and artists feel that complexity, messiness, ill-definedness, and enigmas are fundamental to the nature of human experience, and that therefore all clean and formal models fundamentally distort that nature (Winograd and Flores’s rejection of AI (Winograd and Flores 1986), for example, is fundamentally based on this point). If this is the case, then how can we design systems that can create rich, meaningful, and complex experience for users? I believe we must do so by realizing that we cannot fully represent experience within the software, and instead try to set up more nuanced relationships between (internal, formal, clean) code and (external, messy, complicated) experiences. More concretely, I suggest the following (nonexhaustive) set of heuristics:

• **Instead of representing complexity, trigger it in the mind of the user.** Instead of trying to contain the complexity of user experience in formal structures such as user models, one should focus on shaping the actual (not modeled) experience of the user, which will hopefully be much more complex than its internal, logical representation. One way to do this is to focus on the user’s strength: an ability to engage in complex interpretation using a vast amount of cultural background knowledge. By focusing on how users react, rather than on the internal content of the software, a simple computational artefact can be used to communicate a rich and complex idea. In the Industrial Graveyard, I take advantage of the user’s ‘narrative intelligence’ by providing ‘hooks’ that support narrative understanding of agent behavior. The agent architecture is structured to support symbolic, narrative interpretation, rather than internal optimality, efficiency, and completeness. Systems built using this heuristic have behavior that is internally simple, but appears complex to users thanks to the complexity of human interpretation.

• **Instead of representing complexity, bootstrap off it.** Human behavior is rich, complex, messy, and hard to organize into rules and formal models. This insight can be used to create rich, complex, messy, and subtle computational behavior with little computational cost simply by driving it directly from human behavior. For example, in Traces the motion of the
Chinese dragons is based on simple rules that respond to human movement. Because human movement is complex and the dragons are responding to it in real time, the movement of the dragons is similarly complex. Unlike the previous heuristic, systems built using this heuristic truly have complex behavior— but only because they are driven by complex input.

- **Think of meaning, not information.** Computers care about information. Humans care less about raw data than they do about what information means to them. Focusing on meaning instead of information in the design of computational objects means that we adapt to user experience of information rather than to its internal representation. With the Influencing Machine, for example, we tried to move away from the standard affective computing model in which ‘emotion’ is fundamentally a unit of information to be extracted, manipulated, and communicated, to one in which user interpretation of emotionally valenced postcards, graphics, and sound is central, with the internal informational representation of emotion playing only a supporting role.

6. **THE ENGINEERING OF EVERYDAY LIFE, OR WHERE’S THE FUN?**

How do these heuristics extend to work outside of the museum and beyond AI? One domain in which nonengineering approaches are clearly needed is in everyday life in the home. In current discussions in HCI, the move of computation from desktops and factories into the home and everyday life is considered motivation to alter the efficiency- and task-oriented approaches on which HCI has largely concentrated in favor of fun- and pleasure-based approaches. Underlying this argument is an assumption that Taylorist models may be appropriate for work, but that they do not apply to the home. Yet the historical record makes clear that Taylorist models are central to current home life in the West, especially in America—to the detriment of our quality of life (Bell and Kaye).

Already at the turn of the century, the popularity of Taylorism and the model of factory production which was rapidly and fundamentally changing the American way of life led to attempts to adapt Taylorism to home life (Strasser 1982). Home economist Christine Frederick was perhaps its most ardent proponent; she proposed that housewives engage in motion studies to minimize the amount of movement they spent on household chores such as washing the dishes or doing the laundry. This attempt to adapt Taylorism to the home ran into resistance, for several reasons. First, many home tasks, such as minding children, are not amenable to being fully engineered and controlled. Second, there was no clear reason why housewives needed to be so efficient. Focusing purely on efficiency causes a great reduction in the experience of work, and many housewives saw no need to get more done at the cost of less pleasure and a more unnatural work process.

The situation today has changed. As Ralph Keyes notes,

> At one time the home was considered a refuge from work pressures. Now its inhabitants march to a businesslike beat. The pace at home has become little different from that at work. It calls for huge calendars on the kitchen wall, constant cross-checking of everyone’s schedules, and sophisticated use of complex telephone systems so everyone can stay coordinated…. The tempo of the office and much of its paraphernalia— datebooks, Rolodexes, phone systems, computers, even faxes— have invaded the home. (p. 141)

In fact, especially for two-career families, efficiency and engineering an optimal task schedule are as important at home as at work. What role will HCI play in this? Will we continue the engineering approach, building domestic technology that will allow harried families to cram yet one more activity into a busy schedule, alternating with stress reduction through mindless fun? Or will we design experiences for users that counteract these cultural forces, developing an alternative vision of what home life could be like?

7. **DON’T JUST ENGINEER - LEARN TO LOVE COMPLEXITY AND SPEAK ITS LANGUAGE**

Building computational artifacts that support rich and meaningful human experience requires a variety of perspectives to be combined. Engineering, including technology and algorithm design, is essential in order to be able to turn the vision of an interaction into a functioning system. Traditional and newly created human-computer interaction techniques are needed to support the fine-tuning of interaction and to evaluate the effect the system may have on users. But ‘engineering’ truly rich experiences requires more of system designers than just technical skills. System designers also need to understand and design for the ways in which user experience exceeds our abilities to formalize it. They can’t just love their code; they must learn to love the complexity of user experience as well and be conversant in it. This suggests the incorporation of practices like cultural studies, anthropology, speculative design, surreal art, culture jamming, story-telling, cultural history, sociology, improvisation, and autobiographies, which have found ways to address and understand the complexity of human experience without needing to create complete and formal models of it. Most importantly, it means recognizing the role, not just of fun but of serious play as a form of opening the conceptual space for designing, building, and interacting with the new systems with which we will share our lives.
8. ACKNOWLEDGEMENTS

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9. REFERENCES

Where the Action Is: The Foundations of Embodied Interaction
Paul Dourish
6

Moving Toward Design

The original motivation for exploring embodied interaction was to help
design new systems. The discussion began by trying to understand the
foundation on which tangible and social computing were built, hoping
that this might reveal important lessons for designing and evaluating
new systems. I started by looking at the emergence of novel approaches
to interaction and how they have been realized in different generations
of interactive systems. Although design was the eventual goal, the dis-
cussion took a step back and considered largely theoretical and founda-
tional underpinnings. It is now time to try to make good on the original
promise, and to cross from theory back to design.

This is a troublesome transition. It always is. The difficulty of articu-
lating the relationship between theory and design has persistently
dogged interdisciplinary work in HCI and CSCW for many years. This is
not least because theory and design are fundamentally different sorts of
activities, carried out by different people with different training and pre-
sented to different audiences. The goals and criteria for theoretical
examinations are quite different from those for design exercises.

Consider the example of Computer-Supported Cooperative Work. As
observed earlier, CSCW research has often tried to marry sociological
investigations of working settings with technological design and inter-
ventions into the operation of those settings. What we have learned is
that, despite our best intentions, field studies and design activities often
sit uncomfortably together. Fieldwork and technological design require
different sorts of sensibilities, and despite many attempts to cross “the
great divide” (Bowker et al. 1997), combining the two remains problem-
atic. Despite the premise that the field setting is an incomparably rich
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source of information—often, the only one that matters—it seems a rare occurrence for the design partners in these collaborative research projects actually to visit the field. Most often, they learn of the field through the reports of their fieldworker colleagues. In these cases, the success of the project often hinges on the fieldworkers’ ability to communicate and translate their understandings in terms that are meaningful to the constructive activities of design. In many cases, though, even this level of communication is more than can be achieved, and instead communication takes place through the pages of journals and discussions at conferences. The different perspectives, concerns, orientation, and training of the participants result in each partner’s feeling that the others fail to understand the complexity of their position. So, just as it has been a common critique of technological design for cooperative work that it fails to capture the subtlety and nuance of the setting (see, for example, Blomberg, Suchman, and Trigg’s account [1997a] of a collaborative design project), so, too, have researchers on both sides of the “social/technical divide” bemoaned the bulleted lists that commonly appear under the title “Implications for Design” at the close of CSCW papers reporting on ethnographic fieldwork.1 To the design community, these “implications” often seem obvious, insubstantial, or vague; to the sociologists, they deny the richness of the settings to which they refer.

This is not just a practical concern; it is a research issue. Plowman, Rogers, and Ramage (1995) analyzed those papers published over a few years’ worth of CSCW conferences with a particular concentration on the role of workplace studies in the design process. They warn of the dangers of expecting or requiring workplace studies to address design concerns, and argue that the design implications of such studies should arise through an explicit dialogue between researchers from different disciplines (rather than require social scientists to be able to engage in design, or vice versa). Elsewhere, drawing on their experiences in a number of interdisciplinary CSCW projects, Hughes et al. (1995) present a framework that they use to communicate ethnographic results to audiences who are unfamiliar with the approach, and may be looking for ways to understand fieldwork findings as rubrics for design rather than as purely observational materials. The framework reflects the tension involved in “translating” the analytic materials of social science into specific proposals for design.
Of course, these problems are not unique to CSCW. The discussions of the relative roles of theory and design/practice in CSCW tend to echo similar discussions that have taken place elsewhere. For example, the latter half of the 1980s saw a similar struggle to find a workable relationship between theory and practice in HCI design (e.g., Long and Dowell 1989; Newell and Card 1983; Carroll and Campbell 1986; Carroll and Kellogg 1989; Carroll and Campbell 1989; Barnard 1991). On one hand, theoretical models of human cognitive processing offered complex, systematic accounts of the cognitive burdens associated with interface designs, while on the other, the pace of technological development and commercial interface design seemed to mitigate against the adoption of theory-based techniques in real-world settings.

Studying the practices of real-world interface designers, Bellotti (1989) noted two particular problems with using theoretical design models. First, the approaches were often laborious and time-consuming to apply, especially because they typically operated at a micro-level of analysis. Second, the models tended to be so “theory-laden” that, in fact, only their developers (who were well versed in the theories on which they were based) could apply them effectively, putting them beyond the reach of the practicing HCI designer. Attempts to produce lighter-weight versions of the theoretical evaluative techniques resulted in a move from “cognitive walkthroughs” to “cognitive jogs-throughs” (Rowley and Rhodes 1992) and the emergence of “discount usability” techniques (Neilsen 1989). The debates over the theoretical and practical adequacy of these approaches were never satisfactorily resolved, although when the World Wide Web came along—not to mention the new business models and frenetic pace of development and deployment that came along with it—those who had argued in favor of speed won by default.

Despite the apparent difficulty of forging connections between theory and design practice, there is no question that such a connection is immensely valuable. Both theory and design gain value from being put together. Certainly, the argument is often made that theories become valuable only when they can generate practical results by being harnessed to design. Some—the religiously pragmatic—hold that theory is vague and abstract while design is “real.” However, we could claim that this position is exactly backward; theory grounds design by providing a
framework within which hypotheses can be constructed and tested, options explored and compared, and results analyzed, evaluated, and verified. From this perspective, design is simply speculative without an understanding of how and why it works; theory makes design real, because it places design in a context that explains it. Whichever position we hold, though, a working relationship between theoretical understanding and design practice is crucial.

In this spirit, the theoretical explorations of the last few chapters are intended to ground design efforts in a variety of ways to be explored here. First, they should provide a common vocabulary and conceptual apparatus for thinking about design opportunities and design features. Second, they should help us understand how the different elements of embodied interaction are related to each other, to help cross-fertilization and to capitalize on the realization that this is a common framework. Third, they should provide a set of principles that shape and define the design of new artifacts.

The question of cross-fertilization will be addressed further in the next chapter. Here, I will concentrate on the design questions. First, I will explore the context for design that embodied interaction provides. Then, I will set out a set of design principles for embodied interaction that explore different concerns for designers of interactive systems based on the embodied approach.

A Common Framework
The core of my argument throughout this book is that social and tangible computing share a common foundation in embodied interaction. That is the theoretical perspective. However, social and tangible computing have both given rise to a variety of design principles and prototypes. It seems to make sense, then, to begin thinking about the design implications and consequences of the embodied approach by trying to understand what principles lie behind tangible and social computing, and what implications they might have for each other. I will examine them separately.

At the heart of tangible computing is the relationship between activities and the space in which they are carried out. Tangible computing explores this in three related ways: through the configurability of space, through the relationship of body to task, and through physical constraints.
By "the configurability of space," I mean the ways in which tangible computing allows users to arrange the environment to meet their own particular needs. Tangible designs often associate particular sorts of functionality with different physical objects, whose distribution in a workspace is then under the control of the user (at least up to a point). The use of phicons in something like the metaDESK is an obvious example. By reconfiguring spatial arrangements, users can reconfigure system functionality; by tailoring the physical environment, they also tailor the computational environment to adapt it to their immediate needs.

Because the body's location and configuration in space is also adjustable, the idea of reconfigurable space leads naturally to the second issue, that of the relationship of the body to the task. Carrying out different aspects of an activity, we may need to be closer, farther away, or in different orientations to the objects of work at hand. We move around the action as the task requires. So the distribution in space introduced by tangible computing also supports a negotiable relationship between body configuration and the computation being employed in a task. Configuring the space and configuring the body are carried out relative to each other.

Of course, there are limits to reconfigurations of body and space that can be carried out in current tangible systems. Some limits are technical, imposed by the current state of the art in fundamental technologies such as sensing, tracking, or display systems. Others, however, are deliberate design features. Exploiting physical constraints is an important part of the tangible-computing design approach. Drawing on Gibson's notion of affordances, tangible-computing designers have sought to create artifacts whose form leads users naturally to the functionality that they embody while steering them away from inconsistent uses by exploiting physical constraints. As a simple example, two objects cannot be in the same place at the same time, so a "mutual exclusion" constraint can be embodied directly in the mapping of data objects onto physical ones; or objects can be designed so that they fit together only in certain ways, making it impossible for users to connect them in ways that might make sense physically, but not computationally.

Turning now to social computing, we see that, like its tangible counterpart, it centrally argues that interaction with software systems needs to be
seen in a broader context than has been traditionally imagined, and that
the influence this broader context has important consequences for the
design of interactive technologies. The broader context on which it draws
is the socially constructed setting within which the interaction takes place.
Where traditional approaches formulate interaction in terms of two sets
of capabilities—the raw functional capabilities of the software and the
raw cognitive capabilities of the user—social computing introduces a new
model. This model is based on alternative views of human social behavior,
obseving that the sequential organization of interaction does not simply
result from the “execution” of a formal plan in the user’s head, but
instead arises from a process of continual response to the circumstances
within which it was being produced—circumstances that include not only
a set of prior expectations about likely actions, but also the outcome of
earlier actions and the emergence of new concerns and opportunities.
Users are not what Garfinkel (1967), in his critique of conventional socio-
logical analysis, had dubbed “judgmental dopes,” blindly following
instructions whose sense is hidden from them; they are active participants,
improvising action by creatively responding to the setting in which the
find themselves.

What does this mean for design? The immediate response is to change
interactive systems in two ways. The first is to support the improvised
sequential organization action by giving users more direct control over
how activity is managed, perhaps by organizing the interaction as informal
assemblage of steps rather than a rote procedure driven by the sys-
tem. The introduction of flexible workflow systems (e.g., Ellis, Kedda,
and Rozenberg 1995; Dourish et al. 1996) demonstrate this sort of
change. The second response is to help support the process of impro-
vised, situated action by making the immediate circumstances of the
work more visible. The insight here that the setting in which the work
emerges includes the current state of the system; the system should make
information available to the user to guide their activity moment by
moment.

Just as before, we can see that although tangible and social computing
share some concerns, there are differences of emphasis. The concern
with the “setting-ed,” contingent nature of action that social computing
addresses has much in common with the relationship between activities
and environment that is central to tangible computing. However, what social computing adds to this is the idea of action as practice. Practice implies not only the detail of what people actually do, but also that the action fits into a wider scheme of ongoing activity that makes it meaningful. Further, it implies that action is situated within a community of practice, which provides its members with a set of common orientations and expectations, fluid but persistent over time. The community of practice determines the shared systems of meaning and values; acquiring mastery of a practice involves the gradual movement of an individual into the community, and the ability to apply meaning and values in the way in ways appropriate to the community. This aspect of setting-ed behavior goes beyond the concerns that tangible computing introduces. It goes beyond the physical, of course, but it also goes beyond the immediate, here-and-now concern of a single user encountering tangible environments on a single occasion. It draws attention to the evolution of practice, and to the ways in which practices evolve around technologies, over time, and within a community. The idea that any given interaction between user and system is, in fact, just one point in a trajectory of interactions between that system and different users, or that user and different systems, is one that has generally been lacking from tangible computing analyses—even though, given its emphasis on familiarity and naturalness of interaction, it is clearly a central issue.

So, the broader idea of embodied interaction points out that action and meaning arise in specific settings—physical, social, organizational, cultural, and so forth. These are generally operative principles; the ways in which they work their way out in one case or another are matters for design.

Design Principles
So much for the background. Now it is time to focus on the question of design itself.

The way we will do this here is by setting out and exploring a set of principles. These are not design recommendations, rules, or guidelines. Rules would lay down a method for design; guidelines would suggest to a designer what to do. However, given the variety of settings in which the embodied interaction approach is applied, it would be inappropriate
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to give rules or guidelines here. Instead, these principles observe or com-
ment upon general features of embodied interaction that occur across a
range of settings. They take elements from the theoretical understanding
developed so far, and show how they are particularly important for
design. The principles will affect different designs in different ways; they
overlap but reflect different aspects of the foundational position I have
been developing. They point out a set of “things to pay attention to”
when doing design and show how these concerns arise in specific design
examples.

There are six principles that will be explored here: Computation is a
medium; Meaning arises on multiple levels; Users, not designers, create
and communicate meaning; Users, not designers, manage coupling;
Embodied technologies participate in the world they represent; and
Embodied interaction turns action into meaning.

Principle: Computation is a medium.

In the previous chapter, I presented a model of embodiment largely in
terms of meaning. Embodied interaction concerns how meaning is cre-
ated, established, and communicated through the incorporation of tech-
nologies into practice. Because meaning is being transferred and shared
through interactive technologies, the first principle that can be drawn
out from the model of embodied interaction is that computation is a
medium.

The idea of computation as a medium has some history in the develop-
ment of computer systems, and particularly interactive computer systems.
Some aspects are straightforward and widely accepted—for example, the
role of programming languages as media for the expression and communica-
tion of algorithms and models, or the increasing range of communica-
tive opportunities afforded by networked computers, including electronic
mail, instant messaging, and video-conferencing. Certainly, these are exam-
pies of computers providing a medium for communication. They exploit
the computer's ability to represent and convey information. However, they
do not make computation the central element of the communicative act. In
an audio or video conference, the role of the computer is largely incidental,
or hidden; in fact, similar effects could be achieved using purely analog,
rather than digital, technologies. What I want to do here is to consider the
idea of computation, rather than computers, as a medium. Meaning is conveyed not simply through digital encodings, but through the way that computation enlivens those encodings with semantic and effective power.

This is an idea that has been particularly important to various proponents of computers in education. Pioneers such as Seymour Papert or Alan Kay have proposed the use of computers as a tool for learning, in contrast to the skills-based "computer literacy" approach that is often the spur to incorporating computers into the curriculum. Papert and his colleagues advocate computers as tools for constructive learning. Inspired by psychological theories of learning, they argue that by building active representations—programs—children learn how to explore abstract ideas and mathematical relationships, in much the same way that physical construction toys can provide children with an intuitive facility with mechanical ideas. This is a vision that has computation, rather than computers, at its heart. It is through computation that children's ideas will be expressed, and through computation that they will be shared, explored, communicated, and developed.3

Although the idea of computation as a medium is not new, it does shed some light on the design issues for embodied interaction through the questions it raises. What sort of communication is going on? And how is it taking place?

First, we can see communication taking place both across time and across space. Communication across space—from one place or individual to another—is manifested in the various uses of embodied technologies within groups, between people, or for collaborative tasks. Communication across time applies also to those cases in which the system maintains persistent information, such as records of activities. These forms apply both to direct and indirect channels of communication—the patient record card, for example, embodies both of these.

Naturally, these two modes of communication are often combined. One example encountered earlier is the communication between a designer and a user through the medium of the system itself. The structure of the system—its design and its functionality—communicates to the user some set of expectations that the designer held for its use—the uses to which it might be put, the circumstances in which it might be used, and so on.
Communication of this sort is an inherent feature of almost any technological design. What is particularly relevant here, exploring these questions from the perspective of embodied interaction, is the second question, How is this communication achieved?

The essence of a medium is that it can be modulated. Media are modulated when they are transformed in some way to carry information. Modulation is a very particular form of transformation—the medium's essential identity remains the same, but the transformation can be separated from it so that information can be both encoded and decoded. The modulation is the actual carrier of information—in terms of embodied interaction, the carrier of meaning. This implies that, in the case of embodied interaction, the modulation must encompass not only the technology, but also the practice in which the technology is embedded. So, meaning is communicated not simply in how the technology is transformed, but in how that transformation affects practice, by transforming it, restricting it, or extending it.

As an example of the way that meaning is transmitted not only through a system but also through the practices that surround it, consider the emergence of particular styles of information on the World Wide Web. At the simplest level, the Web is a medium for the transmission of information to end-users. But in terms of the broader perspective, we need to think of the Web not simply in terms of the information it carries, but in terms of, first, the expectations that people might have about the information they will find there, and second, the uses to which they will put the information they encounter. Bly et al. (1998) explored the emergence of personal Web pages in organizations and showed that the ways people represented themselves on their Web pages could be seen as a way of making their knowledge more available to coworkers. Elsewhere, Erickson (1996) explored the idea of the Web, and especially home pages, as a “social hypertext,” concentrating in particular on the phenomenon of people whose pages link to those of their friends, who in turn have links to more friends, and so forth, so that the set of pages describes a social network. These sorts of observations point out patterns not just in the information that a Web page encodes, but also in the way in which people will use that information. Commonly held understandings like these—understandings of the genres of Web page that might be
encountered—create expectations and background knowledge that frames how people understand and interpret the information that they find. The meaning of the information is not simply what the system conveys, but how it fits into a wider pattern of practice. The medium is not simply the representation that is conveyed, but how that representation becomes active in practice.

Being able to encode a signal in a medium is of little value unless the signal can be decoded and the information content extracted. In interactive and collaborative systems, this typically arises as variety of issues around the topic of “visibility.” First, there is the visibility of the activities of one person to another, across time and space; second, there is the visibility of the effect of the system in modulating that activity; and third, there is the visibility of the system’s behavior in response to some user activity, whether that activity is being enacted or simply considered.

In the collaborative systems area, the problems of the visibility of the actions of one individual to another is known as “awareness,” and has been recognized for some time as critical to the success of many collaborative technologies. Approaches to providing awareness information have included visualization mechanisms for real-time collaboration (e.g., Gutwin and Greenberg 1998; Dourish and Bellotti 1992), and information management and presentation mechanisms for asynchronous work (e.g., Hill et al. 1992).

The ability to “see” another’s actions “through” the system can be provided explicitly by “awareness interfaces,” but more often, it will be something that users must learn to do by observing activities that take place in the system or information space. However, only actions “within” the system tend to be visible, while frequently it is actions “without” that matter. Users must be able to understand how activities within the system are related to activities without; that is, how the system modulates the effects of a user’s action. The most obvious way to learn this is through being able to see how our own activities are modulated when we interact with a system; developing an appreciation for how our own actions are reflected in the information space helps us to understand how a particular state of affairs might be the result of a sequence of activities by someone else. This is another area in which the embodied approach—and in particular, the emphasis that it places on direct engagement and feedback—is
particularly related to the notion of computation as a medium. Embodi-
ment offers opportunities for a much more direct apprehension of the
modulating, mediating effect that computation plays in interaction.

Finally here, chapter 3 discussed the need for an interactive system to
convey to users an account of how it operates, so they can have a more
direct understanding of the potential and actual consequences of their
own actions. At that point, we encountered this idea during an explora-
tion of how sociological understandings could improve system design,
exploring the nature of the “interaction” between user and system from
the perspective of ethnotechnology. Here, we encounter the same idea
in a different guise. Our reason to consider the visibility of a system’s
mechanism this time is for the “feedback loop” that it provides. By mak-
ing a model of the system’s action available, this feedback loop also
presents a model of the outcome of user action—a communicative action
conveyed through the medium of computation. Effective communication
relies on the ability of the “sender” to be able to control the medium,
and the feedback loop is an essential element of this control.

I do not want to present a strict account of embodied interaction as
communication, or to draw analogies from formal understandings of
communication such as Information Theory. Instead, I want to use the
idea of computation as a medium to orient design toward certain per-
spectives and opportunities. It highlights the active nature of computer
systems—the fact that they do things—in a different way; not as the
actions of independent agents, but as augmentations and amplifications
of our own activities. This encourages a focus not on the capabilities of
the technology per se, but on how that technology is embedded into a set
of practices. Practices modulate systems as signals modulate media. In
turn, this orientation toward practice opens up a different set of design
approaches and opportunities for embodied interaction.

*Principle: Meaning arises on multiple levels.*

The analytic exploration of embodied interaction has repeatedly
uncovered the way that objects carry meaning on multiple levels: as enti-
ties in their own right, as signifiers of social meaning, as elements in sys-
tems of practice, and so on. Artifacts and representations carry different
sorts of meanings simultaneously, and activities are caught up in many
different tasks at the same time. This analytic perspective clearly has consequences for design, too. Systems or artifacts supporting embodied interaction need to be designed with an orientation toward the multiplicity of meanings that may be conveyed through them. As I will discuss shortly, creating and managing meaning cannot simply be the responsibility of the designer. However, the designer has a critical role to play in making systems open to multiple forms of use.

The different levels of meaning involve artifacts and representations in different ways. There is a variety of ways in which artifacts can convey meaning as a part of their patterns of use. Some of these can be separated out along two dimensions, iconic/symbolic and object/action. Although these dimensions do not support rigid classifications, they help unpack the issues by characterizing aspects of the representation and the entity to which it refers.

The iconic/symbolic dimension describes the relationship between the representation and whatever it represents. Symbolic representations are abstract ones, in which the form of the representation and the form of the represented entity are largely unrelated. So, the numeral “1” stands for the number one on a purely symbolic level. In contrast, an iconic representation attempts to depict the entity it represents, at some level of abstraction. For example, a map is a more iconic representation of a region of space due to the fact that it is a structural depiction of the space—its internal structure attempts to stand in some recognizable relationship to the space it represents. Of course, the distinction between iconic and symbolic representations is a rough-and-ready one; most representations have elements of both, and it can be hard to separate the features of the representation itself from the features of its cultural interpretation. For example, we are so familiar with graphical arrows that they seem to naturally, almost iconically, depict some kind of motion or directionality, even though, of course, they are purely abstract objects that we are used to interpreting in that way.4

The second dimension concerns the entity to which the representation refers. We distinguish between representations of objects—people and other entities—on one hand, and of actions—events, operations, and behaviors—on the other. Again, this is only an approximate classification. Direct representations of objects might well, of course, indirectly
represent activities, by showing the movements or changes of those objects; and at the same time, representations of actions often convey something of the people who engaged in those actions or the objects to which those actions were applied. This blend of properties allows us to define a dimension between two extremes.

Figure 6.1 shows a number of features of embodied systems mapped according to these dimensions. The phicons on the Media Lab’s metaDESK, for example, represent buildings on the MIT campus; they are iconic representations of objects. The lenses and beamsplitter phicons used in Illuminating Light are also iconic, but are more suggestive of actions, because users typically act through them to produce an effect upon the light beams. The lenses in the metaDESK are even more oriented toward actions, because they represent not objects in the target domain, but activities within the interface—magnifying objects or seeing other details. Similarly, Harrison et al. (1998) introduce a range of tangible interaction devices for information appliances, including a touch-sensitive strip that allows people to “turn the pages” of an electronic book, and a PDA augmented with accelerometers used to control a Rolodex application by tilting the PDA backward.

![Diagram of actions and objects](image-url)

**Figure 6.1**
An abstract space of different forms of meaning-carrying.
and forward. The "page-turning" interface is again much closer to action than to object, but its stylized nature renders it less iconic than, say, the tilting mechanism embodied in the Rolodex application. Among the more symbolic representations, the wear and tear on the medical record cards is a symbolic indication of the activity that has been performed on them, while the handwriting is a less symbolic (more direct) indication of the person who wrote on them.

Representations of all these sorts are the stock-in-trade of user interface design, embodied or not. Interface metaphors are the conventional face of interaction—from sets of associations such as those classed as the traditional "desktop metaphor" to icons that represent files, progress bars that represent system action, and all the rest of the graphical conventions through which a system's activity and resources are conveyed. Interface designers draw on analogies and metaphors from the real world to convey the interactive opportunities a system offers to users. What embodied interaction adds to existing representational practice is the understanding that representations are also themselves artifacts. Not only do they allow users to "reach through" and act upon the entity being represented, but they can also themselves be acted upon—picked up, examined, manipulated, and rearranged.

The foundational exploration of embodied interaction forces us to revise our understandings of the relationship between representations, objects, and actions. Traditional approaches would insist on strong separations between representation and object, or between object and action, whereas the embodied perspective shows that these are simply different attitudes that we can take toward aspects of the world. Something can be simultaneously representation, object, and action, carrying different meanings, values, and consequences. From a design perspective, this draws attention to the way that artifacts may carry multiple meanings for users according to the different ways they are used, and any or all of these aspectual meanings may be in play at any given moment. Similarly, it also shows that, while system designers have control largely over just the representations encoded in the software, the meaning of the system extends beyond simply the software to the whole environment in which the software is used. Much of what will go on, then, is outside the system developer's direct control. It is important not to imagine that the application's boundaries contain everything that matters.
When there are multiple levels at which an entity can be manipulated, and when different degrees of representational effect are embodied in a single artifact, design needs to consider how those different levels of representation will be manipulated, and how users control whether they are acting "on" or "through" some artifact. The question is how to select and combine elements from different levels of meaning. This is a question of coupling, and it leads to another set of principles.

**Principle:** Users, not designers, create and communicate meaning.

**Principle:** Users, not designers, manage coupling.

Traditional interactive system design ascribes two sets of responsibilities to the designer. The first is responsibility for the artifact—for its form and function, and for how they are related. The second is responsibility for its use—for the sets of activities in which people will engage with that artifact.

The first of these, the artifact itself, is something for which designers have primary responsibility. It is not solely their responsibility, of course. Since the 1970s, new approaches such as User-Centered Design and Participatory Design\(^5\) have reexamined the power balance between different "stakeholders" in the design process, and how their different needs and perspectives can be reflected in the design. At the same time, technological developments such as end-user programming provide a new basis for computational design that can remove the requirement for traditional programming training for designing software, making it more accessible to users and so encouraging their participation in the design process. Examples include the use of "macro" programming, which allows sequences of application action to be combined to create new specialized behaviors; "visual" programming, which uses graphical depictions of system behavior both to specify and explain system activity; and "programming by demonstration," in which the system can recognize repeated sequences of user action and make them available as new commands.\(^6\) Despite these developments, though, end-user programming techniques have not made many inroads so far into common development practice, and so technical ability and qualification still stand as entrance requirements for participation in the design of technical systems. The "designer," formally designated, still has primary responsibility for the artifact.
However, the second responsibility ascribed to the designer—responsibility for the way the artifact is used—is open to considerably more debate. Obviously, artifacts must be designed with at least some expectation of their probable use. However, designers are continually surprised at the uses to which their artifacts are put, or the ways in which they are incorporated into the activities of users. In some ways, this should not be a surprise in light of earlier discussions. Chapter 3 presented studies of working practice and situated action that describe the moment-to-moment organization of activity as an improvised affair, crafted in response to the immediate circumstances in which it arises. Improvisation draws on a variety of resources in the environment, including not only physical and social resources but also technological resources. So, how technology will feature as an aspect of working practice cannot be predetermined by the designer, but instead will emerge from the specific, situated activity in which the technology is incorporated.

Although it plays such a major role in successful technology adoption, the process of users adapting and incorporating systems into practice has rarely been studied explicitly. Some specific examinations of technology adoption, such as Orlikowski’s explorations of the use of Lotus Notes (Orlikowski 1992, 1995), have shown this process of “appropriation” to be critically important, and one theoretical perspective—Adaptive Structuration Theory9 (Poole and de Sanctis 1990)—directly incorporates this notion. However, a comprehensive understanding of how this process works has not yet been incorporated into the mainstream of interactive system development.

Nonetheless, the themes explored here such as the setting-ed nature of working practice, illustrate the importance of this process. Technological systems need to be adapted to the widely different nature of work process and practice in each setting in which they are used; they must be appropriated and incorporated as a part of a specific set of working practices. In designing software systems, then, we need to be alert to the ways in which systems offer, to their users, the resources that will allow them to adapt and appropriate it.

For embodied technologies, these issues manifest themselves in terms of these two principles. Embodied technologies are used to create and communicate meaning, managed at multiple levels through selective
coupling; and because they can only have meaning through the way in which users incorporate them into working practices, then clearly the manipulation of meaning and coupling are primarily the responsibility of users, not of designers. This is partly a question of definition. Coupling, as I use the term here, is an intentional connection that arises in the course of interaction, so while designers might suggest a coupling, they cannot actually make one. Only the user can do that, because coupling only happens in use. By the same token, the forms of meaning that a tool might suggest will be incorporated into systems of meaning, categories, reference, and practice maintained by and shared within a community of practice; and this incorporation will, inevitably, transform them. So again, because meaning is an aspect of use, interaction, and practice, it is something that resides primarily in the hands of the user, and not of the designer.

These observations have an impact on designers in two ways. The first concerns the designer's stance, whereas the second concerns the designer's activity.

By the designer's stance, I mean the designer's conception of what he or she is doing, and in particular, of his or her role in an interaction between the user and the artifact. The traditional approach to interactive system design positions the designer as managing the interaction between the user and the artifact through control of the design parameters for the artifact. This stance is reflected in the tools available to interactive system designers—task-analytic methods to model the activities in which the user is engaged, user-modeling methods to understand the user's point of view in the course of interaction, cognitive-evaluative techniques to assess the cognitive impact of different design options, and so forth. The traditional approach offers these tools to designers so that they can explore the different possible interactive paths that a user might follow with an artifact and select from among them the path that best optimizes the different variables at work, such as suitability-for-task or ease-of-use.

This stance has to be transformed when we recognize that users play a much more active role in determining precisely how a technology will meet their needs—needs that are continually changing, and that will be satisfied using a variety of features of the setting, of which the technological artifact is only one. In other words, the precise way in which the
artifact will be used to accomplish the work will be determined by the user, rather than by the designer. Instead of designing ways for the artifact to be used, the designer instead needs to focus on ways for the user to understand the tool and understand how to apply it to each situation. The designer's stance is revised as the designer is less directly "present" in the interaction between the user and the artifact.

So in turn, the revised stance will result in a different set of design activities and concerns. The designer's attention will be drawn to a different set of issues—a new set of problems and potential solutions. In particular, the designer's attention is now focused on the resources that a design should provide to users in order for them to appropriate the artifact and incorporate it into their practice.

The first resource is the ability to operate on entities at different levels—both acting with them and acting through them. This is one outcome of attempts to exploit "concreteness" in interfaces. For example, the user interface to the Self programming environment made concreteness a primary goal, reflecting the underlying philosophy of the language (Smith, Malone, and Ungar 1995; Ungar and Smith 1987). Their relevant feature here is that all actions can be carried out directly on the object to which they refer. By all actions, I mean not only the normal actions that one might expect to be able to perform (pressing buttons, selecting objects, etc.) but also "meta-operations" and configuration. So not only can users operate on a menu to select an operation, but they can also manipulate the menu itself—grab it; break it down into its individual components; pick up the menu items, move them around, and embed them in other objects; change the menus, colors, and feedback options; and so on.

In other words, a single locus of action supports both action on and action through the menu. In contrast, conventional approaches separate the use of an artifact from its manipulation and configuration. These "behind-the-scenes" operations are typically carried out through some other mechanism—often a separate configuration editor or control panel. The "concrete" approach offers both visibility (of which, more shortly) and direct end-user control. Coupling is a matter for users, not for developers. Separating forms of action in the interface typically prejudices one over another, as well as interfering with ways in which users can fluidly move back and forth between acting with and through;
between an orientation toward the system as an artifact or the system as equipment, in Heidegger's terms.

The second critical resource for embodied use that the designer must address is visibility. As mentioned earlier, in the CSCW community, visibility is generally addressed as the support for “awareness” in collaborative systems. Awareness is the informal, often tacit, understanding that collaborators have of each other’s activities. Being aware of each other’s activities helps collaborators organize their own activities to contribute to the progress of the group’s work. For example, if I see that you’re working on the text of a document we’re writing together, then perhaps I’ll realize that working on the text myself would interfere with what you’re doing; instead, I’ll work on getting all the citation information we need. The role of awareness as an element in the coordination of work emerged first from field studies of collaborative work, most markedly in co-present working settings such as the London Underground control room studied by Heath and Luff (1992). The idea also proved a useful analytic tool for laboratory studies of novel collaborative technologies (Dourish and Bellotti 1992) and in turn motivated the design of technologies explicitly oriented toward the promotion of an informal awareness among the members of a group (Borning and Travers 1991; Gutwin and Greenberg 1998). Awareness technologies provided group members with views or representations of each other and their work, to help them coordinate their actions smoothly. Awareness in collaborative systems may arise directly through the visibility of other people’s action, or indirectly through the visibility of the effects of actions on the objects of work.

The “visibility of action” aspect is most obviously at work in systems like Portholes (Dourish and Bly 1992) in which low-resolution video images of offices and public spaces are provided to the members of a distributed work group in order to give them an at-a-glance view of group activity (see figure 6.2). The technology that supported Portholes is crude by today’s standards, but high-quality moving images would have detracted from the system’s goal of providing an awareness of “what’s going on” that doesn’t distract from the work at hand. Portholes, along with a number of other systems that have provided Portholes-like views (e.g., NYNEX Portholes [Lee et al. 1997]; Peepholes [Greenberg 1996];
Figure 6.2
The Portholes system helps distributed groups maintain an awareness of each other’s activities by sharing slow-scan video images across a network. Reprinted by permission of Xerox Research Centre Europe.

Postcards [Narine et al. 1997; ArgoHalls [Gajewska, Manasse, and Redell 1995]), provides participants with a direct view of the actions of others.

In contrast, systems that provide access to a common artifact can use a different approach, in which what is conveyed is not the activity of others but its effects. This is the “shared feedback” approach (Dourish and Bellotti 1992). This approach fits naturally with the synchronous shared editors that were, at that time, a common research tool. A shared text editor, for example, allows multiple participants, each working at a separate networked computer, to work simultaneously on the same document. Some systems maintain a single cursor in the document and allow the participants to negotiate for control over it; others provide multiple “edit points” in the document so that each participant can be entering and editing text simultaneously at different points in the same document. Though this sort of collaborative system occurs less often in more recent research, the ideas are now more common in commercial products—either groupware systems like GroupKit (Roseman and Greenberg 1996) or remote presentation systems like Microsoft’s NetMeeting. The same shared feedback approach applies to all these systems. Shared feedback is a natural
extension of the conventional feedback loop in any graphical interface. As I enter text in a normal, single-user text editor, the editor gives me feedback on my actions. I see the letters I type appear on the screen; I see the cursor move along, from left to right and wrap onto the next line; I see the scroll box move to reflect my current position in the document. Similarly, other sorts of applications—spreadsheets, Web browsers, file managers, and so forth—display the results of my action as I make them, giving me feedback on what I've done. There are two ways to think about this sort of feedback. One way is to think about it as part of the interface; it's a way in which the system displays information to me about how the application is responding to my actions. The second is to think about it as part of the artifact to which the application gives me access; my actions are transforming the artifact, and I can see that transformation take place. Thinking about feedback as a transformation of the artifact leads naturally to the shared feedback approach; in a multiuser application in which the artifact is shared, then naturally all users will see the results of an action because they all see the same artifact.

The shared feedback approach may seem obvious, but in fact it was put forward as an alternative to a number of other approaches that had been proposed to the problems of shared access and awareness. The prevailing opinion at the time was that being able to see other people's actions would be too distracting. In addition, shared feedback imposes some technical constraints. Some applications, for example, offer conceptual models involving independent action over copies of an artifact, which the system will later integrate. By separating the artifacts that different people work on, this approach interferes with shared feedback. Others applications choose not to use the artifact as a channel of communication, but instead present abstract representations of action as separate elements of the interface.

Awareness mechanisms in collaborative systems allow people to coordinate their activity as an ongoing feature of their work, rather than having the coordination provided rigidly by the system. They can adapt their work to the immediate needs of the moment. Similarly, chapter 3 introduced the “accounts” mechanism, which attempts to make the action of single-user software systems observable and intelligible to their users, so that people can coordinate their actions appropriately to the current state
of the software system. Both of these techniques hinge on the importance of visibility in letting people manage their own actions.

The need to manage their own actions arises, in turn, from the fact that those actions take on meaning for the users, as a part of a system of meaning and practice arising around the work being done. Meaning, and its coupling to the features and representations the system offers, emerge from the actions of users, not designers. The principle that users are in control of these aspects of interaction leads to radically different approaches to design.

**Principle: Embodied technologies participate in the world they represent.**

One of the hallmarks of the embodied perspective is the relationship it puts forward between representation and action. Heidegger argued that meaning arises from engaged action in the world. Similarly, just as phenomenology rejects the Cartesian separation of mind and body, I have laid out a model of artifacts-in-use that rejects a traditional separation between representation and object. The embodied perspective is built on the unification of these dualities, on the fact that mind and body, or representation and object, are not entities that dwell in two different worlds, but are participants in a single coextensive reality. So, embodiment does not denote physical reality, but participative status. Similarly, the technologies of embodied action participate in the world they represent.

This is not just an analytic position, but also one with design consequences. It features in two ways—productively, in the process of design itself, and analytically, in how we might approach the environments into which we might want to introduce those designs.

From the design perspective, consider a “tangible” communication device developed at the MIT Media Lab called inTouch (Brave, Ishii, and Dahley 1998). inTouch consists of two units, each connected to computers linked by a network. As shown in figure 6.3, each unit consists of three rollers mounted side by side. The mechanism in which the rollers are mounted contains sensors and actuators; movement of the rollers is communicated to the host computer, which can also cause the rollers to rotate. The software on the computers uses the sensor information from each unit to control the movement of the rollers on the other, so that the actions from one unit are transmitted to the other.
inTouch operates as an abstract communication device between two noncolocated individuals. They communicate by moving the rollers on their own unit, and by feeling the rotation in those rollers caused by the actions of the remote individual. Although there is no obvious language for formal communication through this system, the developers observed in trials that people soon found ways to engage each other through the system, playing games by, for example, attempting to oppose each other’s action, or causing the system to engage in clearly “unnatural” movements such as regular periodic patterns of rotation, sudden starts and stops, and the like. People developed their own private communication mechanisms through inTouch.
The inTouch design directly capitalizes on the relation between representation and participation in embodied interaction design. Technically mediated communication involves the encoding of a communicative act into some representation (e.g., text, audio frequencies, or the position of semaphore flags) that can then be interpreted by the remote participant. In fact, there are two representations at work—a technological representation and a "human-readable" representation. So, when I talk to a friend on the phone, the electrical encodings of acoustic signals form a technical representation, while the spoken language we talk is another level of encoding. In the case of inTouch, the movement of the rollers is the basic technical representation; it is through their movement that information is conveyed from one unit to another. But the movement of the rollers is also the topic that the representation represents. The movement of the rollers isn’t "about" human communication; it’s "about" the movement of the rollers.

The idea of the technology participating in the world it represents emerges, here, in the way in which the rollers directly convey "information" about their own state. There is no further communication—no further meaning—encoded by the system. Users, of course, may develop signs, signals, and conventions that govern the ways in which they communicate through inTouch, but that is something that is familiar to us now—a "reaching through" the technology, a human-managed coupling of action to intentional meaning. The directness of the technological representation allows this flexibility in the management of communicative meaning by the participants.

The relationship between representation and participation can also arise in the analytic stages of system design, and in the exploration of design settings. Recall the discussion concerning medical record forms from chapter 1. In that example, system developers encountered problems when they attempted to create electronic replacements for the cards that were been used to record treatment histories. The reason was that the cards themselves, as physical artifacts, played an important role in coordinating the various activities that go on around a patient, including examination, medication, tests, and measurements. Not only did the words written on the card convey information, but the very writing did,
too—tentative information written in pencil, for instance, or indications of corrections and erasures. In fact, the cards themselves carried important information. Old, worn, or dog-eared cards, for example, indicated that a great deal of activity had taken place over that card (and, by implication, over the patient). So, the card represented information not only about patient treatment, but also “about itself” and about the activities surrounding it.

Although the case of a physical artifact such as a record card is perhaps the most obvious example of this participative property, in other settings it can be encountered in nonphysical entities.

One example arose in an ethnographic study conducted by the Work Practice and Technology (WPT) group at Xerox PARC. The site for the study was a local government organization responsible for the management and execution of large engineering projects. In this organization, which I will refer to here as The Department, a central coordinating artifact for engineering projects was a collection of documents known as the Project Files. Each project had its set of project files, which comprised a paper record of the accumulated history of the project, including all correspondence, internal documentation, plans, schematics, contracts, and so on, that surrounded and documented the activities of the project itself. Although the project files were maintained on paper, The Department was interested in the opportunities and challenges of moving some or all of them online; and it was this interest that provided the opportunity to study their document practices and engage in the cooperative design and deployment of early prototypes (Trigg, Blomberg, and Suchman 1999).

The WPT group developed and deployed a set of innovative document-management solutions that were attuned to the specific document practices the group encountered at The Department, and it explored the issues and opportunities around the movement of the Project Files into electronic form.

Building on some of the other issues that arose from the ethnographic work, we developed a second prototype. This system, Macadam (Dourish, Lamping, and Rodden 1999), addressed the questions arising from the ways in which the engineers at The Department would customize the organization of the Project Files according to their own working requirements. The Department uses a common organizational scheme, called the Univer-
usal File System or UFS, which mandates how the Project Files are organized. The UFS is a hierarchical set of categories under which documents are filed. It assigns each of these topics a numerical identifier, which in turn defines the position of any given document in the set of binders that make up the Project Files for any given project. Documents are encoded according to their topic, or, by default, according to the source from which the document had been received. The UFS operates across all projects; it is a common code shared throughout the organization.

However, as Gerson and Star (1986) famously observed in their study of office procedures, "no representation of the world is ever complete or permanent." People working on projects invariably and inevitably find that the UFS was not entirely appropriate to their purposes. Categories prove to be too vague to make it clear where documents should be filed, fail to make distinctions important to the project, separate items that need to be considered together, and are poorly matched to the specific working practices of individuals and groups.\textsuperscript{11} In order to get their work done, then, project members adopt a variety of strategies. One strategy, for example, is to file documents according to \textit{expectations of later needs}; that is, coders try to anticipate when and why the document will be needed again, predict where someone might look for it in that context, and then file the document so that it will be found.

Another strategy is to adapt the UFS to each project's needs. The materials collected by the ethnographers included various "amended" UFS structures that people had created to suit their specific projects. In these revised UFS schemes, categories had been elaborated, expanded, and revised to suit the particulars of a project. This adapted use makes the UFS more expressive for a particular group, as well as reducing ambiguous filing by creating a shared "vocabulary" for the project. Although this might ease problems for the specific group using the amended UFS, it also introduces problems, especially for people outside the group. On occasion, other people need to browse the files or locate specific items, but variant forms of the UFS make this more challenging for them. This problem is compounded by the natural life cycle of the Project Files. As a project moves through different stages, carried out by different groups, some or all of the Project Files move with it; and when the project is over, a subset of the files are kept in storage for later reference. This life cycle
has two consequences. First, the expectation is that documents will be filed by one person or one group but may be retrieved by another, so problems with the customization of the UFS are almost inevitable since the customizations are local to specific groups, not shared throughout the organization. Second, because the project moves through different groups, with different needs, there may in fact be a variety of customized UFS versions in operation for the same set of files. Customization interferes with mutual intelligibility; and the use of the project files seems to require mutual intelligibility as a criterion for success.

The problem we tackled was this imbalance between customization and mutual intelligibility, and what sort of technical provisions could be made to address it. The key observation was this: that the structure by which the documents were organized was not simply a means of carrying out the work but was, in fact, an object of collaboration in its own right. The adapted UFS schemes emerged from the concerted work of the group, and represented a collective response to the needs of the work in which they were engaged. As a common means through which their work was to be conducted, a revised UFS was also a common focus of attention and activity. The categorization structure that a group used was not merely a description of the shared information they managed, but an item of information in itself.

Building on this observation, we developed a prototype workspace for activities of The Department, which managed not only the activities over documents, but also the activities over the categorization schemes for those documents. User could transformed the filing scheme—by adding new categories, deleting others, or moving categories around in the schema to reflect different organizations of the work—within the same tool they used to work on documents. This allowed the tool to keep track of two associations. The first was the association between a particular document's category and the particular set of customizations in force at the time, for each individual and for the organizational groups of which they were a part. Essentially, that is the “context” in which the document was categorized. The second association was between the active customizations for one user and those for another—that is, the different ways in which different users had adapted used the UFS. These correspond to the different points of view of different people.
By keeping track of these two information structures, our system could essentially *translate* between one user's view and another. A document filed by one user, according to their version of the UFS, could be presented to a second user in terms of that second user's personal view of the UFS. The system could account for the differences between the perspective under which the document was filed, and the perspective under which it was viewed, and manage a translation that maintained the illusion of two different points of view. This was a step toward restoring the mutual intelligibility throughout the Department that had been disrupted by customizing the UFS.

So our system was inspired by observing that the categorization structures not only represented the work, but also participated in it. This relationship between representation and participation was fundamental to the group's work practice. Unlike medical records or InTouch, participation was not a question of physical manifestation, but one of the role that these conceptual structures played in the work. Nonetheless, the same principle applies to the analysis of work practice and provided the insight necessary to design a prototype that provided explicit support for the Department's requirements.

The relationship between representation and participation, then, can take many different forms, but the same principles apply. Representations work on multiple levels, and so interactive systems need to allow people to operate on them at multiple levels. In different contexts, the same entity may be an object of action or a means by which some action is achieved. The ways in which these transitions are manifested and managed, and the context in which they take place, are issues to which system designers need to pay particular attention.

*Principle: Embodied interaction turns action into meaning.*

The relationship between action and meaning is central to the idea of embodiment. The core idea of an embodied interface is the ability to turn action into meaning.

This does not happen in isolation from the rest of the world. Embodied interaction turns action into meaning as part of a larger system. Meaning, after all, does not reside in the system itself, but in the ways in which it is used. So, the idea of turning action into meaning does not
implies that the system somehow represents meaning, in the ways that have been explored by researchers in areas such as Artificial Intelligence or Knowledge Management. However, even though we are not taking a representational stance, we must still take the relationship between action and meaning as a central concern when designing systems around embodied forms of interaction.

We saw that the relationship of action and meaning was central to the philosophies of Heidegger and Wittgenstein. They emphasize that meaning is embodied in practice, in action in the world. In thinking about the design of interactive systems, this turns our attention away from the artifacts themselves and toward the ways in which people engage with them in different settings. Instead of "technology," Heidegger talks about "equipment"—technology used as or for something: to achieve a goal, to serve a purpose, to amplify an action, and so on. This distinction applies as much to information artifacts as to physical ones.

Chapter 5 distinguished between three different aspects of meaning—intentionality, ontology, and intersubjectivity. Each has different consequences for technology and design.

One of the central questions of intentionality, and one that I have touched on briefly, is whether intentionality is an inherent feature of phenomena like words and actions, or whether they can have meaning only through their interpretation by other intentional actors ("derived" intentionality). So when we look at embodied interaction in a design context, our attention is naturally drawn to the question of interpretation. How can someone interpret and understand the meaning that may be conveyed through an action? What sort of representations might a system provide of the context in which an action arose? Will the user of a system be able to see an action or simply see its consequences? In which cases might the consequences, the action itself, and the context in which the action was carried out each play a part in understanding the meaning that is being conveyed?

These are questions that arise in designing awareness mechanisms for CSCW, for example, as discussed earlier. They also arise in Knowledge Management, a currently popular approach being adopted by a wide range of organizations. Proponents of Knowledge Management try to help organizations to capitalize on the skills embodied in their employees, by creat-
ing organizational knowledge bases that encourage people to share and distribute the information around which the organization’s activities are arranged. The rhetoric of the Knowledge Management community frequently suggests some kind of commodification of knowledge. Knowledge is pictured as an almost physical phenomenon, something that can be extracted, transferred, exchanged, stored, indexed, retrieved, and managed. Various systems and products are available to assist in these different tasks. However, although the Knowledge Management literature concentrates on the repositories in which knowledge is stored and the networks across which it is transmitted, practical investigations show that the real cornerstone of organizational knowing is people. Knowledge Management consultants know this too. Successful efforts often involve appointing “knowledge managers”—people whose role is to understand how the information stored in the repositories can be applied to real problems. So, again, we see a distinction between, on one hand, the idea that knowledge, or meaning, can be represented and stored, and, on the other, the view that it has to be contextualized and made relevant to the settings in which it is to be applied. Meaning is not inherent to information; information is made meaningful. Intentionality is a matter of context, and of doing.

The second aspect of meaning, ontology, concerns how we understand the structure of the domain, and the ways in which people can separate one entity from another (or one kind of entity from another) and understand something of the relationships between them. Again, ways of understanding the structure of the world arise from the ways in which we interact with the world. As a perspective on design, this can perhaps be thought of as an extension of the role of affordances in interface design, as explored by Norman (1988) or Gaver (1991), and as discussed in chapter 3. Traditionally, affordances are features of the artifact (or, more generally, the environment) that afford particular sorts of action to appropriately equipped individuals, in the ways in which the keys on my laptop afford pressing to someone with the right sized fingers, and a doorway affords passage to someone of the appropriate general shape. However, features of the design also afford particular ways of understanding it, and particular ways of conceptualizing the relationship between the artifact and the environment, or between the different conceptual structures that one might encounter in the use of the artifact. In the example of document filing in
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The Department, for instance, the incorporation of different contexts for coding documents transforms the idea of the UFS from being something that is imposed from outside to actually being a variety of artifacts that can be called into play, singly and collectively, as needed.

The third and final aspect of meaning, intersubjectivity, concerns the way in which meaning arises as a collective phenomenon. Its relevance here is that meaning exists not for a single individual but for a community of practice. The concept of community of practice has featured particularly in the work on social theories of learning conducted by Jean Lave and Etienne Wenger (Lave and Wenger 1991; Wenger 1998). Communities of practice share histories, identity, and meaning through their common orientation toward and participation in practical activities. In Lave and Wenger's analysis, learning—and particularly the apprenticeship model—is reconceptualized as the "legitimate peripheral participation" in a community of practice and the gradual movement from peripheral to central participation in the community. In becoming a member of the community, one learns not only to exercise the skills of that community, but also to exercise them as a member of that community—with the same set of understandings, expectations, significances, and meanings that are characteristic of that community and how it sees itself. In technical terms, the issue here is that the technology does not simply afford certain sorts of actions, but that it also reflects particular sets of assumptions, conventions, and practices within a community. This has a number of implications. First, novel designs need to be sensitive to the way in which the artifact is not simply a tool for a job, but reflects these kinds of background assumptions. Second, they need to be designed around the different levels of participation that can be found within a community. And third, because community values change and are continually reproduced and transformed through ongoing practice, the designer needs to consider how the community can express its values through the tool, transforming them over time.

One interesting technical example that we have encountered already is the set of linguistic practices that Cherny reports in her study of an online community in a text-based virtual reality environment (Cherny 1999). Cherny's examples illustrate the ways in which distinctive patterns of interaction emerged within the community, and serve, essentially, as markers of membership. What is particularly significant about this exam-
ple, from the perspective of the design of embodied technologies, is the relationship between technology and practice that it highlights. A number of the linguistic practices that Cherry documents were ones that had arisen, originally, around the peculiarities of the technology as a medium (that is, that the information is presented textually, that utterances are marked with the speaker's name at the start of the line, etc.) but without any specific support from the technology—that is, the verbal and graphical effects were achieved using the generic facilities that the system offered for virtual interaction. A number of them, though, were eventually coded into the system itself, refined and represented within the structure of the system. There are two effects at work here. One is that the members of the community are provided with shortcut tools (specialized commands) to engage in these behaviors; but the other is that the system itself acts as a malleable record of the practices of the community. These commands, and these practices, take on a special significance because of their history and because of the path they have followed. So, although we take a nonrepresentational perspective on the meaning that may arise from action in an embodied system, we recognize nonetheless that there are design opportunities surrounding the ways in which the technology might adapt to different patterns of activity, and that those adaptations might be, themselves, ways in which a community of practice might establish and convey meaning.

Beyond the Principles
By laying out a set of principles that describe aspects of how embodied interaction relates to the artifacts around which it happens, this chapter has attempted to turn from foundational issues to design opportunities. My concern here has been the issues that arise in attempting to create information artifacts that draw on the idea of embodied interaction, and how to evaluate or understand their use in specific settings.

It has been said that talking about music is like dancing about architecture. The same could probably be said of reading about design—especially in the abstract. A set of principles will take you only so far, especially when, as in this case, they really are general principles as opposed to design guidelines, rubrics, or rules of thumb. There are no recipes for successful technology design to be found among the principles. Instead, they are
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intended as stepping-stones, taking us from the more theoretical concerns that have occupied the last few chapters to real artifacts put to real use in real settings. Without specific design problems in front of us, the best way to judge the effectiveness of the principles is to see what kind of analytic purchase they give us in looking at examples of embodied interaction in current systems. Embodiment is a feature of interaction, not of technology. It does not distinguish one sort of interface from another—embodied from nonembodied. Certainly, some systems may lend themselves more to an embodied form of interaction than others, but in general, embodiment is a question of how the technology is used. So we can bring the embodied perspective to bear on a variety of interactional settings, as I have tried to do here.

Presenting the design implications as principles as I have done here is certainly problematic. For one thing, the principles overlap and interact in a variety of ways; they are certainly not distinct. For another, they suggest directions but do not provide hard-and-fast recipes.

However one reason to explore general principles rather than specific design recommendations is in the hope that they will be a little more robust to the rapid pace of technical development. Technological opportunities continue to evolve, and the sets of options available to designers is continually evolving. Principles should be more stable than design practice. A second reason is one that has also been a matter of research investigation here—the importance of context. I have deliberately discussed design implications at a level that will require designers and others interested in exploring embodied interaction to pick and choose how they apply the principles to the different settings, technologies, and needs that characterize each design encounter.

The principles are a starting point, then. They serve to orient us to a set of issues that any specific design may need to explore in more detail. They are the start of a much longer story.