Technology Complicating Our Lives

- Complexity leads to
  - rejection: “complexity causes 50% of returns”
  - avoidance: turning off devices to reduce intrusion
  - underutilization: devices do not work together
- Current trends increasing complexity
  - proliferation: environments w/ 100s of devices
  - pervasiveness: dissolving of “home & work”

“Complexity of computers may become the biggest contributor to any digital divide” – WSJ, 6/13/05

We'd like to simplify our personal lives through simple-to-use technologies

Activity-based Computing can Help Simplify our Lives

- Long-lived activities in our everyday lives
  - e.g., staying healthy, graceful aging, social awareness
  - high-level, physical, dynamic, & high value
- Key application elements
  - social
    - e.g., facilitate relationships
  - natural interactions
    - e.g., speech, multimodal, manipulating familiar objects
  - always at hand
    - e.g., run on mobile devices, allow appropriating devices

Digital Simplicity Example: Computer Coordinated Elder Care

- Long-lived activities in our everyday lives
  - high-level, physical, dynamic, & high value
  - let mom live a healthy & independent life
  - high value to all & simplifies life of the family
- Key application elements
  - social
    - care network: elder, doctors, family, friends, etc.
  - natural interactions
    - mom uses normal utensils & touch interaction natural
  - always at hand
    - picture frame, phone, & web
- Display tested successfully

By High-Level Activity We Mean

- Mom eats regularly
- Mom exercises regularly
- Eat breakfast
- Eat lunch
- Biking
- Stretch
- Get on Bike
- Pedal

Let mom live a healthy & independent life
Activity Theory Offers an Approach

- Activity theory describes human activity as a hierarchy of activities, actions, & operations
- A conceptual framework to achieve activity-based design

Digital Simplicity

Key Challenges & New Ideas

- Physical actions are tedious to record & manage
  Build applications using action inference
- Social relationships are complex & delicate
  Use social inference to inform human actions
- Natural interactions are ambiguous
  Improve disambiguation using dynamic context
- Must study in situ over extended periods
  Use new tools to improve data collection/analysis

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UbiFIT

Cross-cutting App Using Action Inference

- Problem
  - overweight & obesity are a global epidemic
    - over 1 billion affected worldwide ($100+ billion cost in US alone)
  - busy people have hard time fitting exercise into lives
  - ubicomp technologies can encourage long term fitness
- Challenges
  - fitness a long term activity across many actions/locations
  - motivate without being annoying
  - give people “credit” for everything they do
  - use social support without violating norms

UbiFIT

Cross-cutting App Using Action Inference

- Ubiquitous fitness-influencing technologies (UbiFIT)
  - uses multiple at hand platforms (phone, MSP, RFID, web, etc.)
- Automatic capture of common physical actions
  - Mobile Sensing Platform (MSP) infers actions using 7 sensors (walking, running, bicycling, elliptical trainer, sitting, etc.)
- Self awareness using natural & familiar interaction
  - Ambient Garden on phone conveys activity level during day
  - Smart Gym equipment that logs & is queried by voice
- In situ studies to track long term behavior changes
UbiFit

- Status
  - design ideas refined via a 75 participant survey
  - app implemented w/ both self-journaling & inference
  - 3 week pilot with 10-15 participants this March
  - 3 month study with 20 participants this summer

What People Use is the Key to Recognizing Many Actions

Reliable & Robust Sensing

- RFID tags allow robust sensing of object-person interactions
- Early in trials showed about 85% inference accuracy
  - personal appearance
  - oral hygiene
  - toileting
  - make a snack
  - ...
- Large in-facility trial with major health providers planned for 2007

Inferring Physical Activity w/ Mobile Sensing Platform

- Automatically track physical activity throughout the day
  - walking, running, bicycling, going up stairs, elevator, etc.
- Collaboration between Intel & UW
- 2-sided sensor board with
  - 3D acceleration
  - digital compass
  - audio (8kHz, 16bit)
  - barometric pressure/temperature
  - light: HF, ambient, IR
  - humidity/temperature
- Packaged w/ processor, storage, Bluetooth
- Early results show 75-90% accuracy detecting activities real-time

Apps Built With Action Inference

- Key Inference Engine Research Problems
  - Make it easy to create good out-of-box inference engines
    - easy example labeling
    - labeling app & example management/selection tool
    - sensor/feature/action visualization & relearning tools
    - mobile reporting app to collect negative examples & relearn
  - Lower the cost for getting great action inference
    - users directly/indirectly (UI) label examples at opportune times
  - What are good/great recognition rates for a domain?
    - how do you find out for your application?

Digital Simplicity

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Augmented User Study/Design Tools

- **Problem**
  - build the right app
  - what activities & practices to design for?
- build the app right
  - too much expertise required to prototype & study ubicomp apps
  - limited today by laborious & error prone methods

- **Challenges**
  - unobtrusively collecting valid data over extended periods
  - discovering interesting results (e.g., breakdowns) in large data logs
  - understanding the context in which activities of interest take place
  - designing & testing appropriate interactions for a particular context

**Solution:** Apply ubicomp to in-situ user study & design tools

- improve ratio of quality to effort
- capture real usage context using sensors (location, activity)
- collect data for extended periods (weeks to months)

- **User study tools**
  - augment formative/summative study techniques (MyExperience)
  - add location/activity/social info to ESM tools & logging tools
  - anomaly detection & statistical diagnosis to interpret

- **Design tools**
  - analyze activities from longitudinal user study data
  - identify stakeholders, social relationships, actions
  - rapid application prototyping (Activity Designer)
  - visual language for design (PBD, storyboarding)

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**My Experience**

*Context-triggered ESM Tool*

- **Features**
  - multi-media capture (audio, video, etc.)
  - real-time wireless connectivity/data upload
  - context-triggers using real & virtual sensors
  - modern platform support (e.g., phones)

- **Advanced sensor support**
  - scenario: fitness study
    - detect: running
    - wait to prompt...
  - scenario: elder care study
    - detect: medication bottle picked up
    - trigger survey if past lunch & not detected

- **Release for public use**

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**Activity Designer**

*Informal Prototyping for Activity-based UIs*

- Create activity-based scenes
  - actions in a particular situation (e.g., running in the park at lunch)
- Visually create status properties & visual feedback
  - number of times someone ran
  - use scenes & properties as conditions on storyboard transitions
- Iterative design
  - Wizard of Oz (WoZ)
  - test in field w/ actual devices

- Fast & fluid design
  - no special hardware required
  - need not be programmer

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**Visual Language for Property Computation**
**Digital Simplicity Summary**

- Solve high value problems, *simplifying* our lives
  - use long-lived activity as the primary organizing focus
- Solve these problems *simply* using
  - inference: activities, locations, & social context
  - tools: for design & user studies that leverage context-tagged in-situ activities
  - natural UIs: improve recognition using context

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**ActivityDesign**

Activity-Centric Prototyping of Ubicomp Applications for Long-Term, Everyday Activities

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**Digital Simplicity Through Activity-Based Computing**

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