

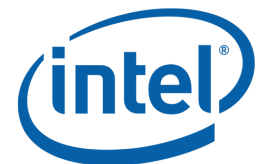
# ENCOURAGING BEHAVIOR CHANGE IN EVERYDAY LIFE WITH MOBILE, PERSUASIVE TECHNOLOGY

**Sunny Consolvo**

Intel Labs Seattle

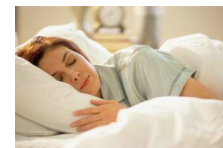
Mon, Feb 14<sup>th</sup>, 2011 ○ UW CSEP590B Smartphone Mobile Computing

**dub** design:  
use:  
build:  
university of washington



## DESIRED VS. ACTUAL LIFESTYLE

- The lifestyle individuals *want* to lead is often not the lifestyle they *do* lead
- Many individuals want to be...
  - **financially secure**, yet consumer debt is on the rise
  - **well-rested**, yet many are sleep deprived
  - **fit & healthy**, yet physical inactivity & poor eating habits are leading to serious health problems worldwide



## EVERYDAY CHOICES

- This can be partially attributed to simple decisions that individuals make everyday
- Sometimes the decisions support the individual's desired lifestyle, other times they do not



## EVERYDAY CHOICES

- This can be partially attributed to simple decisions that individuals make everyday
- Sometimes the decisions support the individual's desired lifestyle, other times they do not

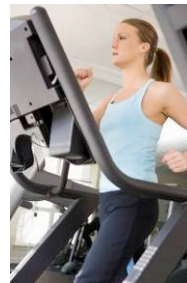


## EVERYDAY CHOICES

- This can be partially attributed to simple decisions that individuals make everyday
- Sometimes the decisions support the individual's desired lifestyle, other times they do not



Work out or watch TV?



## IT'S COMPLICATED

- Making one “wrong” decision seldom prevents the individual from leading her desired lifestyle

[Rachlin, 2004]



## IT'S COMPLICATED

- Making one “wrong” decision seldom prevents the individual from leading her desired lifestyle

[Rachlin, 2004]

one piece of cake  
isn't going to make  
me gain 10 lbs...



## IT'S COMPLICATED





















- Making one “wrong” decision seldom prevents the individual from leading her desired lifestyle

[Rachlin, 2004]





# WHEN SEVERAL ISOLATED CHOICES TURN INTO A PATTERN

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
						
						
						
						

The Plan

# WHEN SEVERAL ISOLATED CHOICES TURN INTO A PATTERN

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
						
						
						

The Reality

# DEVELOPING PERSUASIVE TECHNOLOGIES

- Help individuals stay focused on their long-term goals *while* in the everyday situations in which these decisions are made

Saving



Sleeping



Staying Fit



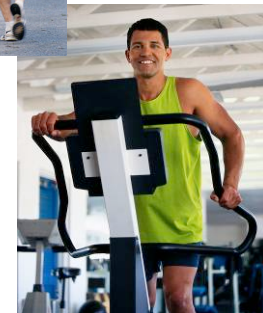
## DEVELOPING PERSUASIVE TECHNOLOGIES

- Our work has focused on using technology to encourage healthy lifestyles, specifically physical activity

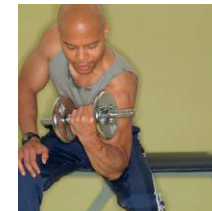


## A SHOW OF HANDS...

1. Considering your walks or cardio activities of 10+ minutes at a time, how many of you...
  - walked at least 30 minutes/day on 5 or more days last week?OR
  - performed at least 20 minutes of cardio exercise per day on 3 or more days last week?



2. How many of you performed strength training (e.g., weight lifting) on at least 2 days last week?



3. How many of you performed flexibility training (e.g., yoga or stretching) on at least 5 days last week?



## OUR SYSTEM: UBIFIT

- UbiFit was designed to encourage individuals to incorporate regular & *varied* physical activity into their everyday lives
- UbiFit targets individuals who are motivated to
  - incorporate physical activity into their everyday lives,
  - have the ability and desire to do so,
  - but have not done so (at least not consistently for  $\geq 6$  months)

↗ i.e., the Contemplation, Preparation, & Action stages of the *Transtheoretical Model of Behavior Change* [Prochaska et al., 1992]

## THE UBIFIT TEAM

- David McDonald (UW)
- James Landay (UW, IL Seattle)
- with...

Alex Wilkie • Anthony LaMarca • Beverly Harrison •  
Daniel Avrahami • Jeff Hightower • Jon Froehlich •  
Jonathan Lester • Keith Mosher • Kieran DelPasqua •  
Louis LeGrand • Mike Chen • Pedja Klasnja • Ryan Libby  
• Tammy Toscos • Tanzeem Choudhury • *and many,  
many others...*

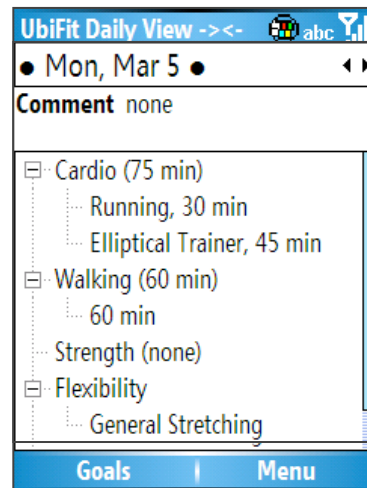
# THE UBIFIT SYSTEM: 3 MAIN COMPONENTS

*Collects data about physical activities*

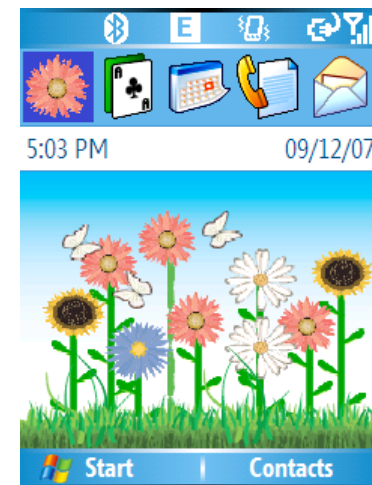
Fitness Device



Interactive Application



Glanceable Display

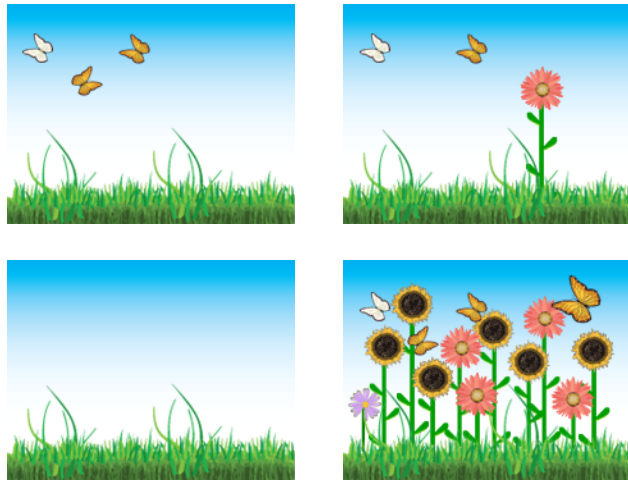


*Communicates data about physical activities*










# GLANCEABLE DISPLAY

*Runs as the mobile phone's wallpaper, so it's frequently seen by the individual*



At-a-glance determination of:

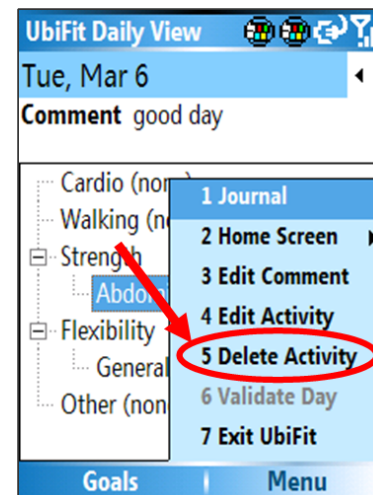
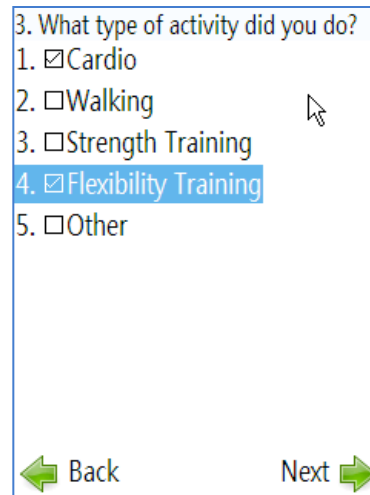
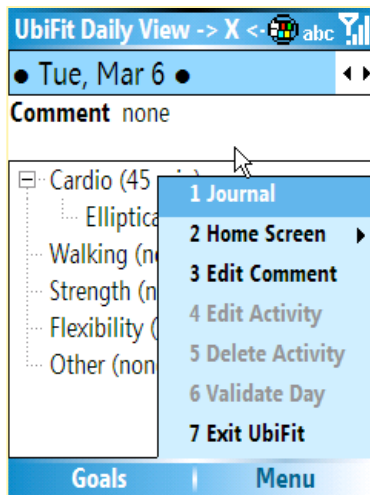
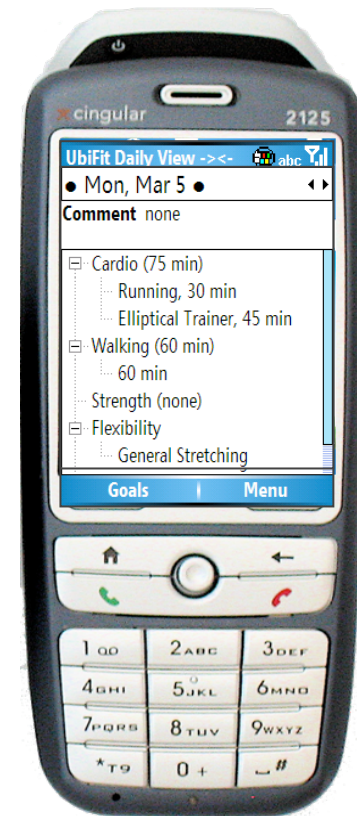
- active or inactive week,
- variety in routine,
- this week's goal met
- recent goal met

-  Cardio
-  Strength
-  Flexibility
-  Walk
-  'Other'
-  Primary/alternate goal met
-  Primary/alternate goal recently met

Uses the  
*MyExperience Toolkit*  
[Froehlich et al, MobiSys '07]

## INTERACTIVE APPLICATION

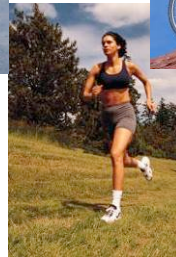
- View a daily list of physical activities performed
- Add/edit/delete activities for today & yesterday
- Correct mistakes made by the fitness device
- View the current weekly goal (& progress toward it)
- Receive pop-up reminders to record activity



## FITNESS DEVICE

- Infers physical activities & their durations, specifically:

- walking
- running
- cycling
- use of elliptical trainer
- use of stair machine



- The sensing & inference run continuously throughout the day
- No explicit interaction is needed, as long as it is powered on & being worn properly



## EVALUATING UBIFIT GARDEN

- Paper-based Survey (n=75)
- 3-Week Field Trial (n=12)
- 3-Month Field Experiment (n=28)
  - Winter '07 – '08 Holiday Season– a time notorious for physical *inactivity* [Pivarnik, Reeves, & Rafferty, 2003]

## 3-WEEK FIELD TRIAL

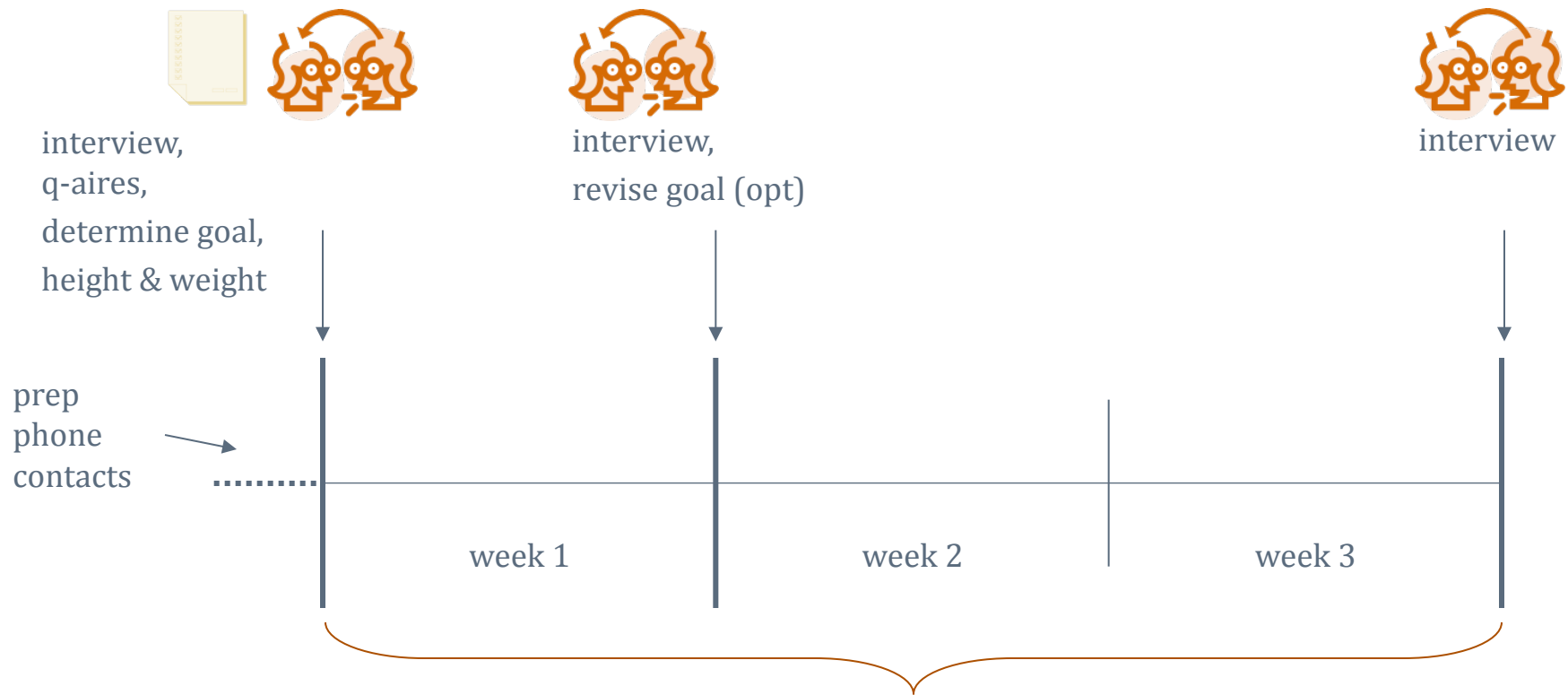


- 3 weeks of system use in the field
- Study focused on
  - General reactions to the system, in particular, the fitness device's activity inference
  - Ensuring that the prototype system and field study design worked well enough *in situ* with participants recruited from the general public

## 3-WEEK FIELD TRIAL (N=12)

- 12 Participants (6 male, 6 female)
- Aged 25-35, lived in Seattle metropolitan area
- Occupations (mostly non-technical)
  - Receptionist, marketing specialist, actor, filmmaker, copywriter, musician, merchandiser, stay at home mom, etc.
- Regularly used mobile phone
- Wanted to increase physical activity
- 11 recruited via market research agency
- Compensated up to \$250 USD in AmEx gift cheques

# 3-WEEK FIELD TRIAL: OVERVIEW OF METHOD



**note:** study phone running ubifit garden was used as the personal phone (i.e., participants' SIM in study phone)



## GENERAL REACTIONS

- *The silly flowers work, you know?...it's right there on your wallpaper so every time you pick up your phone you are seeing it and you're like, 'Oh, look at this. I have all those flowers. I want more flowers.'* It's remarkable, for me it was remarkably like, 'Oh well, if I walk there it's just 10 minutes. I might get another flower.' so, sure, I'll just walk. {P5}



## PERCEIVED ERRORS OF ACTIVITY INFERENCE

- Our analysis revealed 7 types of perceived errors with activity inference
- The fitness device could:
  - ~~make an error in start time~~ — Seldom occurred, so not discussed
  - make an error in duration
  - confuse an activity it **was** trained to infer with another it **was** trained to infer
  - confuse an activity it **was not** trained to infer with one it **was** trained to infer
  - fail to detect an activity it **was not** trained to infer
  - fail to detect an activity it **was** trained to infer
  - detect an activity when none occurred

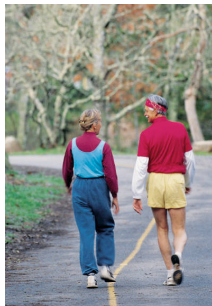
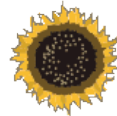


## MAKE AN ERROR IN DURATION

- 17 (of 207) inferred activities were edited for duration
- minor discrepancies of a few minutes weren't a big deal **unless** the activity should have but did not count toward the weekly goal
  - imagine that for a walk to count toward a participant's weekly goal, it had to be 30+ minutes
  - if the device detected a 15 minute walk at 12 minutes, most participants didn't mind (and may not have edited the duration)
  - but if the device detected a 30 minute walk at 29 minutes, they edited the duration

## CONFUSE AN ACTIVITY IT **WAS** TRAINED TO INFER WITH ANOTHER IT **WAS** TRAINED TO INFER

- E.g., ‘walk’ inferred as ‘stair machine’
- In general, more important to get start *time* & *duration* correct than *type* as long as something was inferred
  - [Sometimes the fitness device] *didn't quite know what to make of what I was doing. Um, which is walking...once it detected it, I didn't really mind that it didn't detect the right thing you know. I just wanted it to detect the time. {P1}*



## CONFUSE AN ACTIVITY IT ***WAS NOT*** TRAINED TO INFER WITH ONE IT ***WAS*** TRAINED TO INFER

- E.g., ‘housework’ inferred as ‘cycling’
- In general, this amused participants, and they often appreciated the misattributed recognition
  - *What was really funny was, um, I did, I did some, um a bunch of housework one night. And then boom, boom, boom. I’m getting all these little pink flowers. I’m like ooh, that was very satisfying to get those. {P9}*



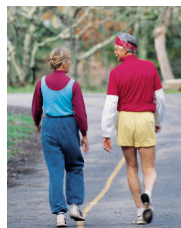
# FAIL TO DETECT AN ACTIVITY IT ***WAS NOT*** TRAINED TO INFER

- E.g., nothing for bouncing or exercise DVD
- Most did not consider this to be an error
- However, two were surprised and disappointed
  - *I took my little girl to <bounce land>... And uh, I did jumping for an hour ... crawling in tunnels and jumping ... but [the fitness device] didn't pick up a thing...you know you're climbing then you're sliding...I mean you'd crawl, you're up, you're down, all around. And so I thought for sure it would've, you know, gotten something but it didn't seem to get anything. {P2}*



## FAIL TO DETECT AN ACTIVITY IT **WAS** TRAINED TO INFER

- E.g., nothing inferred for a ‘walk’
- One of 2 errors that most **negatively affected credibility**
  - *Ah...Why am I wearing you [the fitness device] if you don't pick [the activity] up? {P4}*
  - *It's not the end of the world, [but] it's a little disappointing when you do an activity and [the fitness device] doesn't log [the activity]...and then I think, 'am I doing something wrong?'* {P2}



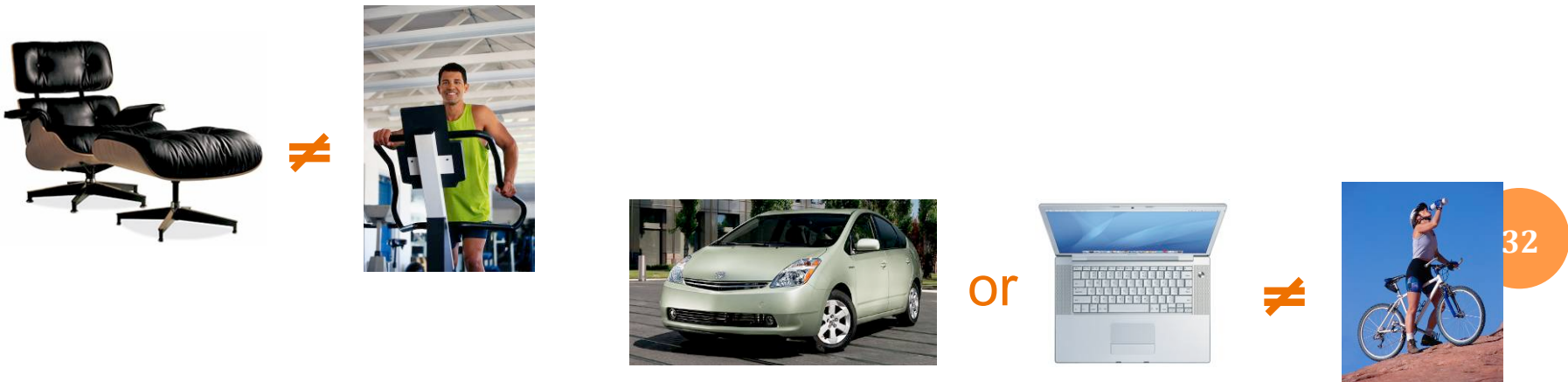
## FAIL TO DETECT AN ACTIVITY IT **WAS** TRAINED TO INFER - CONTD.

- An interesting side effect of this perceived error occurred for one participant:
  - *The [missed] walks I did add manually. But it – cheating is not the right word ...but **it kind of felt like cheating** when I put those manually in **even though there was nothing cheating about it**. I did do [the walks] and it was this long, but it just like, no, [the fitness device] should have figured that out and told me. {P1}*



## DETECT AN ACTIVITY WHEN NONE OCCURRED

- E.g., ‘cycling’ inferred for a ride in the car
  - ‘Cycling’ for typing email at the coffee table
  - ‘Stair Machine’ for relaxing in a recliner
- Though infrequent, this was the other error that most **negatively affected credibility**
- This was **intolerable** (and would likely lead to system—or at least device—abandonment)







## ADD/EDIT/DELETE IMPROVES CREDIBILITY

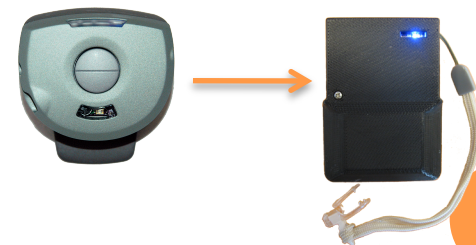
- The capability of participants adding to, editing, & deleting inferred data improved the credibility of the system
- If there had been no add/edit/delete capability, participants wouldn't have liked the system
  - [That would be] *supremely annoying* because it would've been wrong. You know if I couldn't add the things that it missed when it wasn't on *I would've felt jipped*, like, 'Ah! I did meet that goal, damn it! There should have been two more flowers there.' {P8}

## DESPITE PERCEIVED ERRORS, (MOST) PARTICIPANTS WANT INFERENCE

- Considering a self-report only system
  - [It would have been] *somewhat annoying ... that I would've had to track everything, the duration ... as well as the fact that I did it ... When I think I just want [the system] to pick it up by osmosis so I really don't want to have to think about documenting. I just want it to be documented.* {P8}

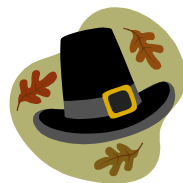
## MOVING TO THE NEXT PHASE

- Revised design to include
  - 5<sup>th</sup> flower for “other” activities 
  - Alternate goal 
- Retrained “not cycling”
- Created 3 versions of the system
  - Full system
  - No glanceable display
  - No fitness device
- Created new case for fitness device



## 3-MONTH FIELD EXPERIMENT

- 3 months of system use in the field
- Study focused on:
  - Teasing apart effects of the fitness device & glanceable display (e.g., how important is each?)
  - Getting beyond potential novelty effects that may have been present in the 3-week trial
  - Observing UbiFit in use at a time known to be particularly sedentary (e.g., bad weather, illness, holidays, end-of-year work/school commitments, out of town visitors, trips, etc.)



## 3-MONTH FIELD EXPERIMENT (N=28)

- 28 Participants (15 female, 13 male)
- 3 conditions
  - full system (N=10)
  - no fitness device (N=9)
  - no glanceable display (N=9)
- Aged 25-54, lived in Seattle metropolitan area
- Occupations (mostly non-technical)
  - pr, real estate, retail sales/mgmt, hr, it support, comedian, stay-at-home mom, psychologist, etc.
- Regularly used mobile phone
- Wanted to increase physical activity
- Recruited via market research agency
- Compensation of up to \$350 USD

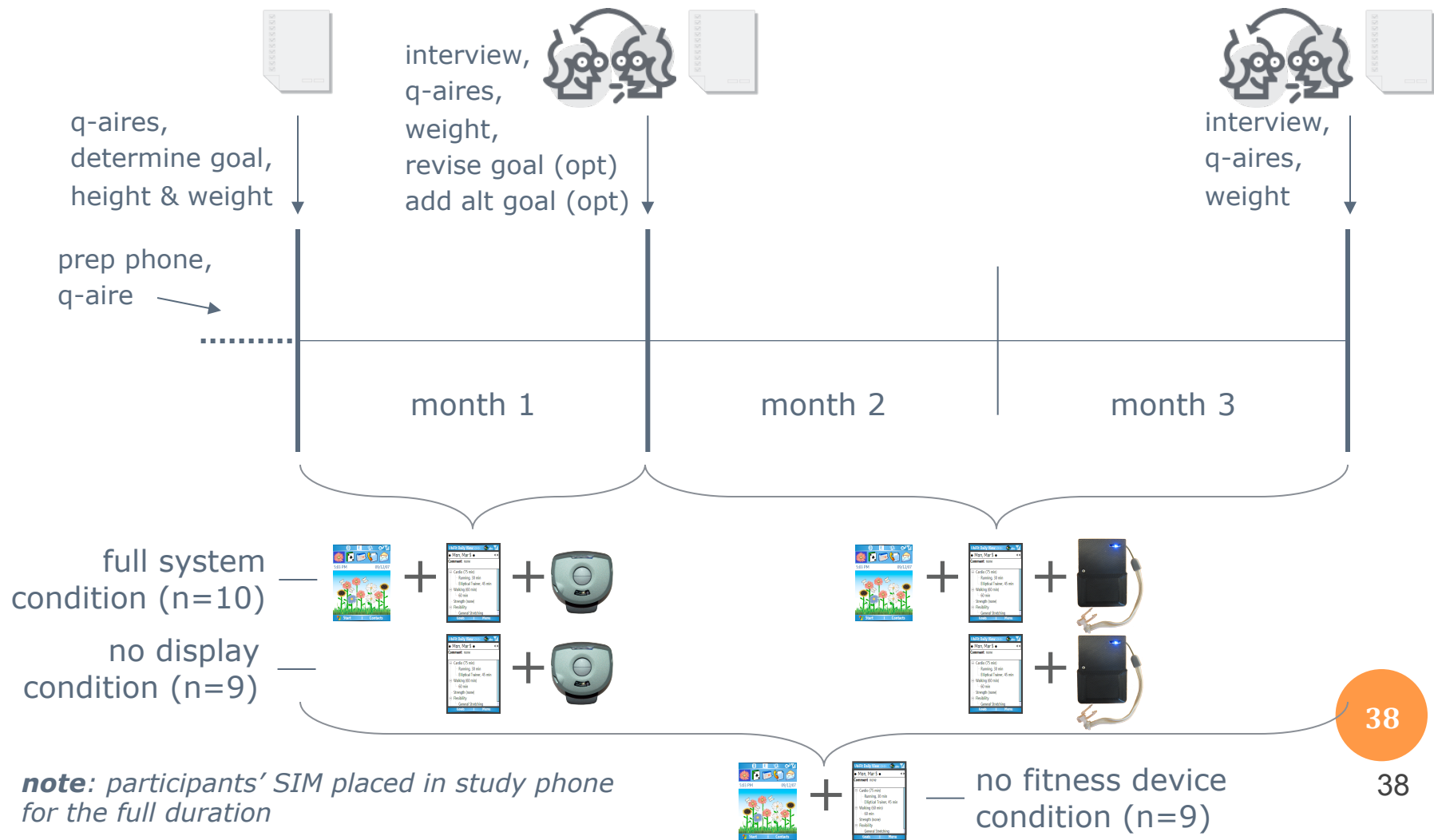
full system

no fitness device

no glanceable display



# 3-MONTH FIELD EXPERIMENT: OVERVIEW OF METHOD

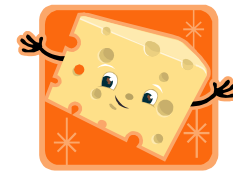


## GENERAL REACTIONS

- [UbiFit Garden has] *really got me motivated...having to log in my exercise has kept me motivated to try and actually exercise to meet my goals. The flowers are cool.* {S5—no fitness device}
- *It's gratifying when I get to the end of the week and it shows that I've done a lot of activity.* {F6—full system}
- [UbiFit Garden is] *there all the time. it's like, 'Did you want to enter something from yesterday or from today?' it's like, 'I didn't do anything yesterday. I'm going to do something before the end of the day today.' so it's a nice, gentle reminder that getting off my duff...every other day is not too much to ask.* {S9}

## THE GLANCEABLE DISPLAY WAS KEY

- All who used the glanceable display (19 of 19) thought that it was a **critical component** of the system
  - Supports results from 3-week field trial
- Most who didn't use it wanted it (6 of 9)
  - 2 of 9 thought it would be nice-to-have
  - 1 of 9 thought it was “so cheesy” {N6}
- *I love that idea...if it's not flowers and butterflies...I mean it's just **something that you don't have to pull up**, you know, **it's right there**...just having it show up there...that would be **a much quicker reminder** because you're looking at the phone so many times during the day anyway. {N10 —no glanceable display}*





## WHY THE GLANCEABLE DISPLAY WAS KEY

- It helped individuals reflect on what they actually do
- It helped them realize how often things “come up”
- It helped them realize how they weren’t making time for fitness
- It kept them focused on fitness
- It reminded them of past accomplishments
- It was available when & where it was needed

## IT HELPED INDIVIDUALS REFLECT ON WHAT THEY ACTUALLY DO

- 26 (of 28) participants reported that prior to the study, they thought they were more active than they actually were
  - Supports findings from 3-week field trial
- *I used [the glanceable display] to increase my awareness of what I was doing... 'cause like... after about two days, you kind of forget, like 'Did I really do that or am I just dreaming or was that last week?' {S1}*

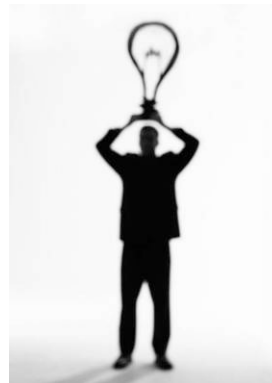
## IT HELPED THEM REALIZE HOW OFTEN THINGS “COME UP”

- [UbiFit Garden] *really helped me learn how often things come up that you know, prevent you from [being active]...[UbiFit Garden] helped me realize how many days you can be sick in the winter and how many days, you know, things just come up...even though you really, really want to get in [to the gym], you know, your kid is sick, and your husband is out of town, and you're not going anywhere. {S1}*



## IT HELPED THEM REALIZE HOW THEY WEREN'T MAKING TIME FOR FITNESS

- *I didn't realize that **I didn't make time for myself**. that was really shocking that I couldn't do whatever, the 20 minutes for the flexibility and the stretching. I mean, **that you could just do watching TV!** ...[before] I would start and I'd be like, 'oh, I'm too tired to do it,' and I wouldn't do it...around December, the week of the 16<sup>th</sup>, things just kind of turned around for me...**a revelation that I just needed to get my act together.** {S7}*



## IT KEPT THEM FOCUSED ON FITNESS

- [The glanceable display] was *a constant reminder... whereas if you didn't have a screen [glanceable display], you probably—I wouldn't think about it [physical activity] as much, you know, I think about it maybe subconsciously every time I look at my phone.* {S5}
- *I tried to go on a walk every week and that type of thing, whereas normally when I'm not tracking [activity], time can get away from you very fast.* {S2}

## IT REMINDED THEM OF PAST ACCOMPLISHMENTS

- *I could see the butterfly and think, 'I did it last week, you can do it again this time.'* {F10}



# IT WAS AVAILABLE WHEN & WHERE IT WAS NEEDED

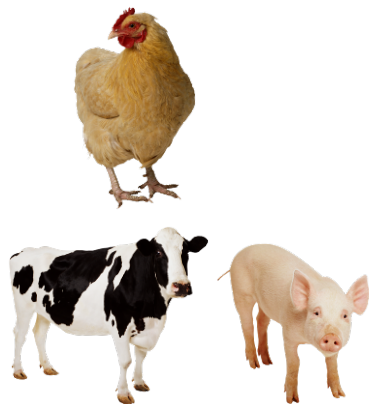
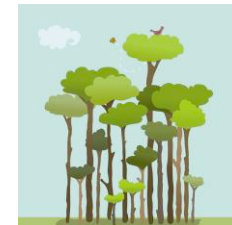
- *I liked having [my garden] be on the phone... something I have with me... [with] a web site, it's so easy, 'Oh, I didn't do anything, I'm not going to click on it.' It's so easy to ignore it. But on the phone, you can't really ignore it as easily... otherwise, it's just... out of sight, out of mind. {S9}*



# UBIFIT \_\_\_\_\_: OTHER METAPHORS

## ○ Common suggestions included

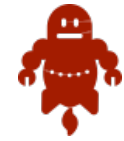
- fish- or animal-related themes,
- sports themes,
- car themes,
- celestial themes,
- beach themes, and
- forest-related themes





## OTHER METAPHORS

- *It would be nice to have a more like dude-ly kind of motif for it [the glanceable display]...like a robot. If you could amass a robot army...I'd run a lot! {F7}*



cardio



strength



flexibility



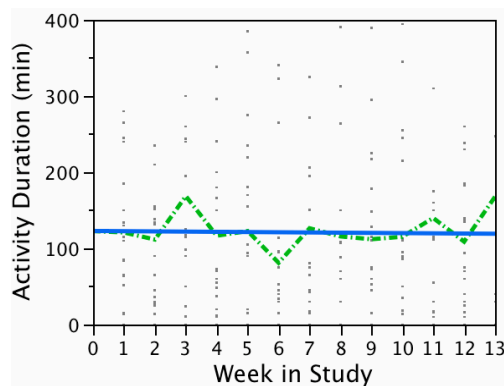
walk



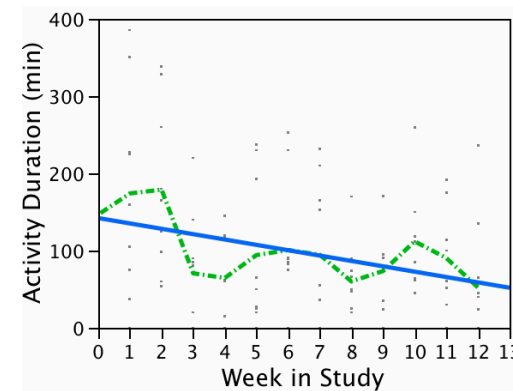
'other'

## QUANTITATIVE FINDINGS

- The interaction between the availability of the *glanceable display* and *week in study* on *activity duration* was significant ( $F[1, 312]=6.51, p<.05$ )
- On average, the amount of time spent in physical activity each week for participants
  - who *had* the glanceable display was *maintained*
  - *without* the glanceable display *decreased* over time



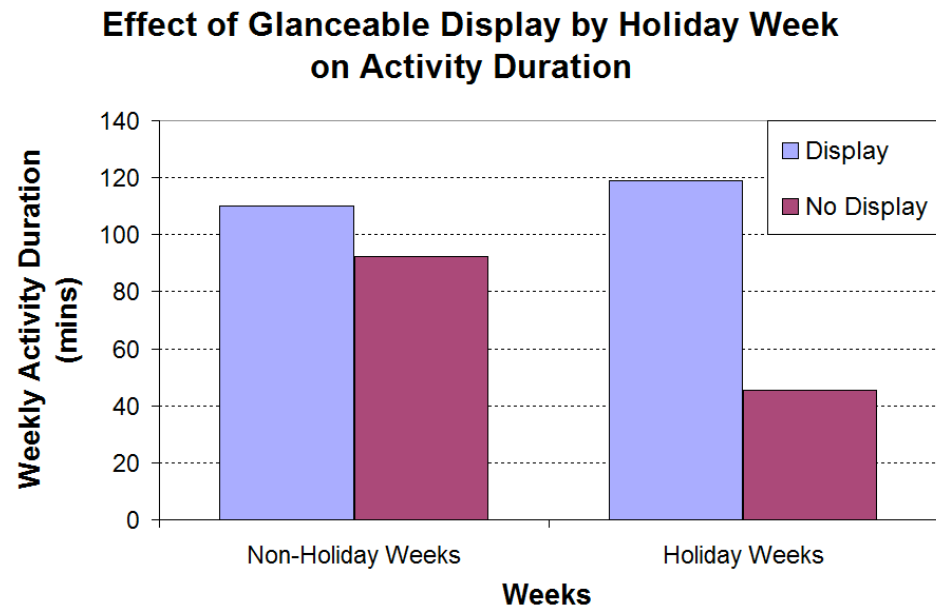
weekly activity duration  
**with** the display



weekly activity duration  
**without** the display

## MORE QUANTITATIVE FINDINGS

- The interaction between the availability of the *glanceable display* and *holiday weeks* was also significant ( $F[1, 311]=4.11, p<.05$ )
- Time spent in activity on weeks that contained a holiday
  - *decreased* for participants who *did not* have the glanceable display
  - *remained as high* as during non-holiday weeks for participants who had the glanceable display

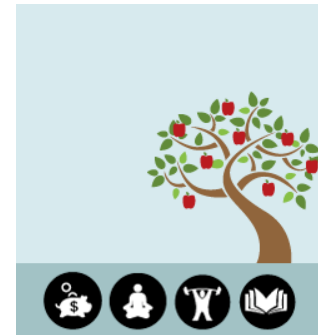


## TO LEARN MORE ABOUT UBIFIT AND THE STUDIES...

- “Using Mobile & Personal Sensing...” AMIA ‘09
- “Designing for Behavior Change...” IEEE Computer (2009)
- “Exploring Privacy Concerns...” Pervasive ‘09
- “Goal-Setting Considerations...” Persuasive ‘09
- “Theory-Driven Design Strategies...” CHI ‘09
- “The Mobile Sensing Platform...” IEEE Pervasive Computing (2008)
- “Flowers or a Robot Army?...” UbiComp ‘08
- “Activity Sensing in the Wild...” CHI ‘08
- “My Experience: A System...” MobiSys ‘07

## MOVING FORWARD: UBIGREEN

- Encouraging green forms of transportation
  - Led by Jon Froehlich (UW)
  - with Tawanna Dillahunt (CMU), Pedja Klasnja (UW), Jen Mankoff (CMU), Beverly Harrison (IL Seattle), & James Landay (UW)
  - *Froehlich et al. "UbiGreen..." CHI '09*



UbiGreen Tree Design



UbiGreen Polar Bear  
Ecosystem Design

# MOVING FORWARD: GOALPOST/GOALLINE

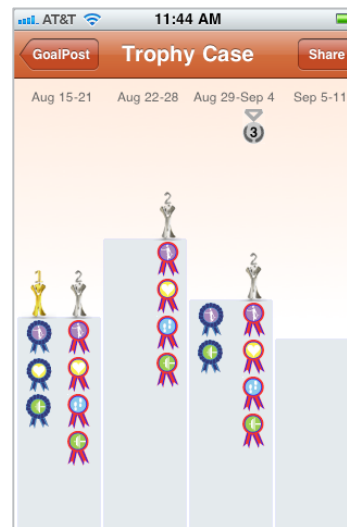
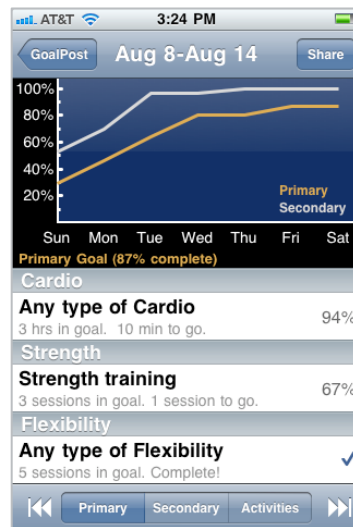
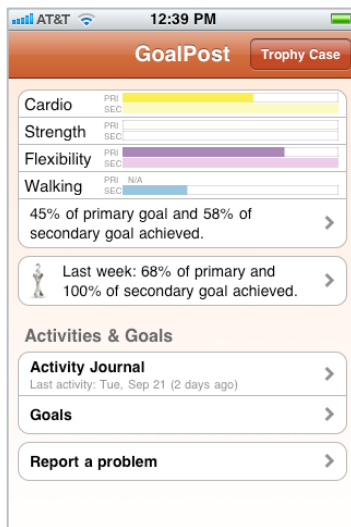
- Exploring goal-setting, reminders, rewards, & sharing to encourage physical activity
  - Led by Sean Munson (U Michigan)
  - with Adidas Innovation Group



Patricia Ticker set a primary physical activity goal for Sun, Sep 19–Sat, Sep 25. It includes 1 session of yoga and 3 hrs of any type of cardio.

[View details on GoalPost](#)

September 17 at 9:28am via GoalPost · Comment · Like



## MOVING FORWARD: SHUT EYE

- Encouraging mindfulness of activities that can impact sleep (e.g., drinking caffeine, exercising)
  - with Jared Bauer (UW), Ben Greenstein (IL Seattle), Jonathan Schooler (UW), Eric Wu (UW), Julie Kientz (UW), & Nate Watson (UW)



## A BIG THANKS TO...

- Adam Rea
  - Alex Wilkie
  - Anthony LaMarca
  - Beverly Harrison
  - Daniel Avrahami
  - David McDonald
  - David Wetherall
  - Dimitri Negroponte
  - Gaetano Borriello
  - Ian Smith
  - James Landay
  - Jean Moran
  - Jeff Hightower
  - Jon Froehlich
  - Jonathan Lester
  - Keith Mosher
  - Kieran del Pasqua
  - Louis LeGrand
  - Maggie Orth
  - Mike Chen
  - Patrick Baudisch
  - Pedja Klasnja
  - Ryan Libby
  - Tammy Toscos
  - Tanzeem Choudhury
- and many other:  
friends,  
family,  
colleagues,  
beta testers,  
participants,  
paper reviewers, &  
members of the press  
who have contributed  
along the way...



## AND TO YOU!

- Questions? Comments?
- [sunny@consolvo.org](mailto:sunny@consolvo.org)
  
- Mobile Health
  - May 4<sup>th</sup> & 5<sup>th</sup>, 2011
  - At Stanford University
  - See [www.mobilehealth.org](http://www.mobilehealth.org) for details

