Still crazy/hopeful after all these years...

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“Approximately 25 years ago, government and industry invested in expanded access at a crucial time in the Internet’s development. The resulting networks and ubiquity of access provided fertile ground for technologies, ideas, institutions, markets, and cultures to innovate. The payoff from this investment created a commercially viable and largely self-governing ecosystem for innovation.

The same can be done for global health. Government, commercial, and nongovernmental entities involved in health IT and innovation should cooperate to define and instantiate architecture, governance, and business models and to steer initial mHealth investments into open architecture.”


Open mHealth initiative: [http://openmhealth.org](http://openmhealth.org)
Importance of an open platform: avoid silos, promote innovation and transparency

Bootstrap rapid cycle of learning, sharing, deployment
- ~80% (guesstimate) system components reusable
- Largest missing pieces: authoring, analysis-visualization, feedback

Facilitate research in methodology, treatment
- Systems gather usage data automatically for evaluation, iterative improvement
- Encourage modularity and sharing in methodologies, practice

Development in the context of real applications and use
- Collaborative/participatory design process with continual feedback from users
- Diverse targeted pilots inform generalization, adaptation, expansion.

Explore balancing of privacy protection and data sharing
- Variety of privacy/sharing policies
- Transparency of research and data processes for participants
Open architecture and community promote rate, range, rigor of innovation and productization

- Allow innovators and entrepreneurs to focus on their unique market offerings while increasing the validity, robustness and efficiency of shared components and methods

- Particularly in above-the-waist sense-making tools that consume mHealth data and make them useful to end-users

http://openmhealth.org

Estrin, Sim, et al
Essential features of innovation infrastructure for mHealth: *Modularity, Sharing, Analytics, Iteration*

- **Modular** components w/well defined interfaces
  - enable decentralized, parallel, asynchronous innovation
  - broad participation, rapid iteration.

- **Shared** architectures benefit from economies of scale, shared learning
  - all the boats float higher
  - state of knowledge, tools improve exponentially

- **Analytics** drive iterative adaptation, improvement in *relevant* time
  - leverage digital nature to continually collect data on usage and behavior
  - like Internet search engines, underlying Internet transport protocols

- **Iteratively** design, deploy, evaluate, and adapt mHealth innovations
  - mHealth data collection and interventions are new--a lot to learn about what works for whom
  - takes health science domain experts, technologists, designers, statisticians
Data: opportunities and barriers

- Opportunities (complements ‘big-data mining’)
  - Mobile phone
  - Wearables
  - Home
  - Personal digital exhaust (‘cloud sensing’)
  - Crowd sourcing

- Barriers
  - Sensemaking tools, techniques, methods to make new data useful and usable--personally and clinically
  - Engagement with tools; Tools for engagement
  - Lack of living laboratories--lack collaboration, funding, infrastructure to support iteration, scale, embodiment
  - Missing a culture/process of modularity, reuse, open architectures which we need to achieve usable multifunction systems
  - Valleys of death: is this CS or Health research? is it research or engineering?
Still hopeful after all these years

• collaborative research studies and data commons (Sage Bionetworks Bridge and Synapse projects)
  iOS only at this time

• standardized clinical representation and aggregate measures (Open mHealth)
Sage Bionetworks and ResearchKit “Bridge” Citizen Interface Initiative

Bridge Server captures longitudinal mobile health data
Open mhealth architecture circa 2015: community-defined APIs, data schema, to imbue and access digital health data w/ clinical context

- open-source (on GitHub)
- written in mainstream tech
  - Java, backend stuff
  - HTML/CSS/JS, front-end stuff
  - Docker to provide isolation
  - can use other languages behind the APIs
Integration with existing APIs

- Provide libraries called shims that
  - call existing APIs
  - translate response data to Open mHealth format
- Run within Shimmer appliance
- Shimmer support for
  - call existing APIs:
    - Fitbit, RunKeeper, Withings, Jawbone, Misfit
    - iHealth
    - HealthVault
    - Google Fit
    - Apple via Granola library (serializes HealthKit data)
Ohmage-omh: Open mHealth compliant, open source, experimental platform

**Downloadable Applications**

- **Mobility-omh**
  Continuous passive measurement for activity and location

- **PAM-omh**
  Visual tool for affect/mood self-report

- **ohmage-mobile**
  Platform for distributing data collection surveys and acquiring survey responses

- **Third Party Applications**
  Commercial applications such as Moves or Fitbit integrated through Open mHealth shims

**Admin Dashboard**

- Retrieve data from authorized participants of their studies

**Research Applications**

- Pain Levels from Back Surgery
- Rheumatoid Arthritis
- Urology Post-operation Problems
- Urology Surgery Post-operation Recovery Line
- Obesity and Nutrition Project
- Weill Cornell Medical Center Residency Program
- Hip and Knee Orthopedic Surgery (pre and post surgery)
- Lower Back Pain/Arthritis

small data: beyond mobile

**purchases**
what I bought
when I bought it
where I bought it

**mobility**
how much I moved
where I was
where I got to

**finances**
how much I spend
how much I save

**location**
where I am
where I was

**email**
who I write
who writes me
how I write
when I write

**calendars**
when I’m busy
what I’m busy doing
small data fueled applications example: Ora

share how you are doing, not what you are doing
small data experimentation (sdX)

w/ Choudhury, Juels, Pollak, et al