ICTD Capstone
Software Design for Underserved Populations

CSE 482b

Course Overview, March 31, 2021

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Today

- Capstone Courses
- Project Ideas
- My background

Development Engineering

- Technological interventions to improve human and economic conditions in low-resource settings
- An engineering discipline aimed at addressing global inequity
- Develop principles for design, introduction, scaling, and sustainability of Global Good technology

What are the challenges

- Domain challenges: Health, Education, Agriculture, Markets, Livelihoods, Infrastructure, Sanitation, Energy, Environmental Degradation

- Resource constraints: Finance, Infrastructure, Distance, Education and literacy, Governance

- Shocks: Climate Change, Global Pandemics

Setting

- Rapid, global economic and technological change
  - Many technologies are globally accessible
- Not just a split between “Developed” and “Developing Countries”, but within countries between “Urban-Affluent” and “Rural/Urban-Poor”
- In many ways, the world is getting better
  - Increasing literacy rates
  - Decline in maternal mortality rates
  - Near elimination of diseases such as polio

ICTD, Information and Computing Technologies for Development

- Technology with global impact
- Appropriate for `low resource' settings
- Target development domains
  - Health, Education, Livelihood, Agriculture, Disaster Relief
- This quarter – many of the proposed projects around global Covid-19 immunization

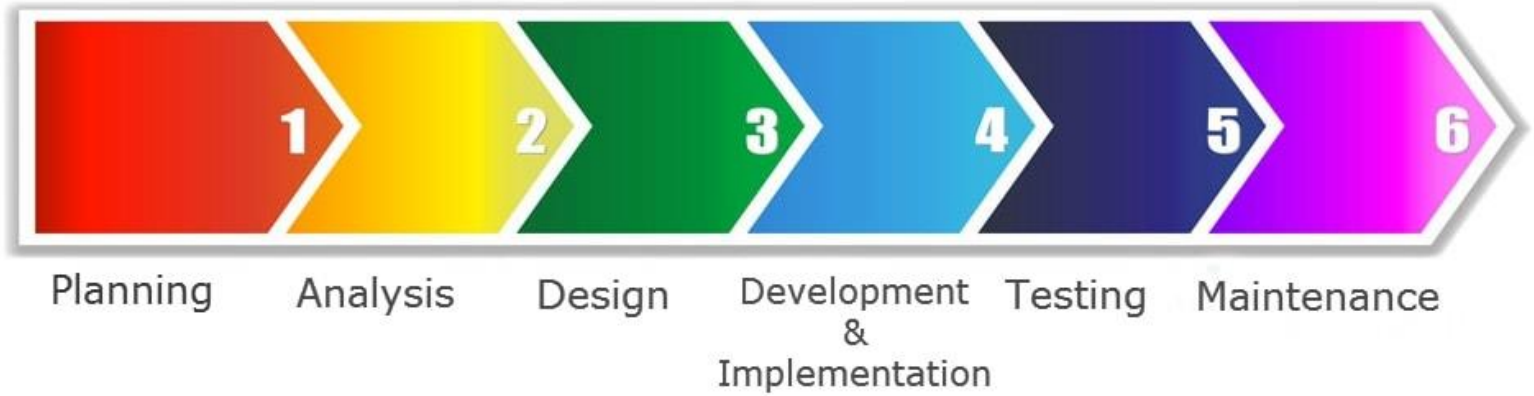
CSE Capstone courses

- **Capstone Goals**
  - Projects must be large enough to require teams of several students to work on over one quarter.
  - Students must apply concepts from more than one sub-area of CSE (at the 300-level and above).
  - The work must involve a substantial design effort.
  - Students must present their work using formal oral presentations and written reports.
  - Efforts must culminate in an interesting, working artifact.

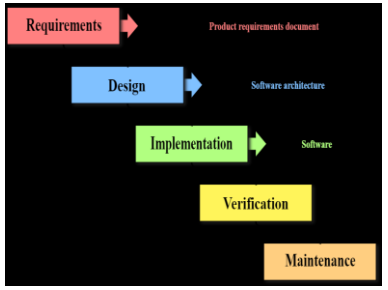
What I expect in a capstone

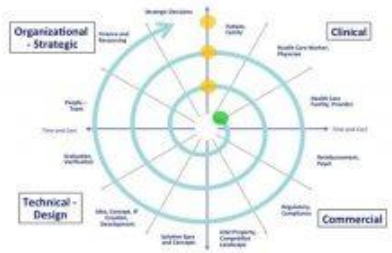
- Group projects
  - About five people
  - Different roles
- Design and Implementation
- Multiple check points and expert review
- Working, useful software
- Reasonable software process
- Presentation of results

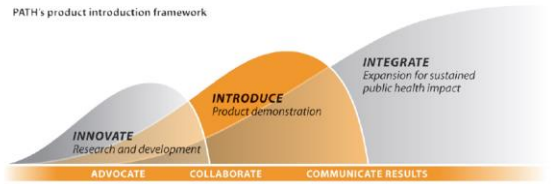
The capstone challenge



- Too much stuff to fit into nine weeks in the spring
- Focus on Design, Development & Implementation
- Choose at start of course from a set of project ideas







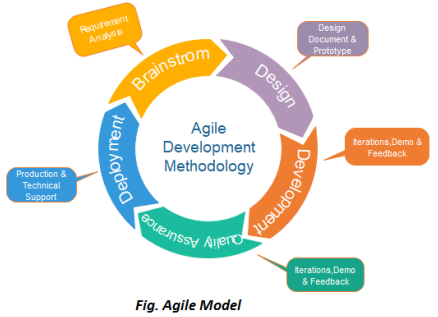


Fig. Agile Model

Schedule

- Today – present project ideas
- Thursday – establish project groups

Schedule (Dates tentative)	
Project Pitch	
Progress Report and Prototype	
Final Presentations	
Deliverables due: Code, Writeup	

Course Mechanics

- Group development of projects
- Lectures/class meetings for first few weeks
- Regular group meetings with course staff
- Later class sessions for presentations and demos
- Specific deliverables will be specified during the quarter
- Final turn in will include code and a paper (~10 pages)

Project Ideas

1. Vaccine Stock Tracker
2. Vaccine Passport
3. Immunization Campaign Planning System
4. Notification / Registration tool.
5. Vaccine Impact Modelling tool.
6. Speed Test App for Tacoma Community Cellular Network
7. Red Cross Data Reporting Tool

1. Vaccine Stock Tracker

- Problem: A country needs to keep track of vaccines as they are used in immunization campaigns
  - This is going to be particularly important for Covid vaccines as they are expensive, limited in availability, and are likely to supplied irregularly
  - Tracking vaccines needed for initial allocation as well as collecting unused vaccines after a campaign
- This project could be integrated into our existing Cold-Chain Information System
  - Mobile application for vaccine logisticians
  - Dashboard for ministry of health
  - Deployment in Uganda underway

1. Vaccine Passport

2. Vaccine Passport

- Allow verification of vaccination status
- Basic model allows established authorities to enter vaccine information and others to verify credentials
- Should have some basis in cryptography or digital signatures
- Could involve mobile apps for vaccinated and/or verifiers
- Need to consider multiple different components of the system

3. Immunization Campaign Planning Tool

- Developing countries will likely rely on campaigns for Covid immunization
  - Identify population group and locations
  - Plan for campaign with supplies and schedule
  - Required data: demographics and health system information
- Create various web based planning tools
- Will require some background research and domain knowledge
- Possible applications of Algorithms or AI

4. Notification and registration tool

- Tool to support tracking of individuals for immunization
- Target needs of a developing country (such as Uganda)
- Multi-dose vaccines complicate this problem
- Integrate across multiple messaging technologies

5. Vaccine impact modelling tool

- Develop framework for modeling impact of Covid vaccination
- Framework would allow various different models to be used
  - Fairly naïve models could be implemented initially with a mechanism for domain experts to add models later
- Scenario: tracking progress of global immunization and predicting impacts of different immunization approaches and coverages
- Variables to consider: Vaccine type, populations, coverage by dose, efficacy on different strains
- Possibly set up as a global modelling tool

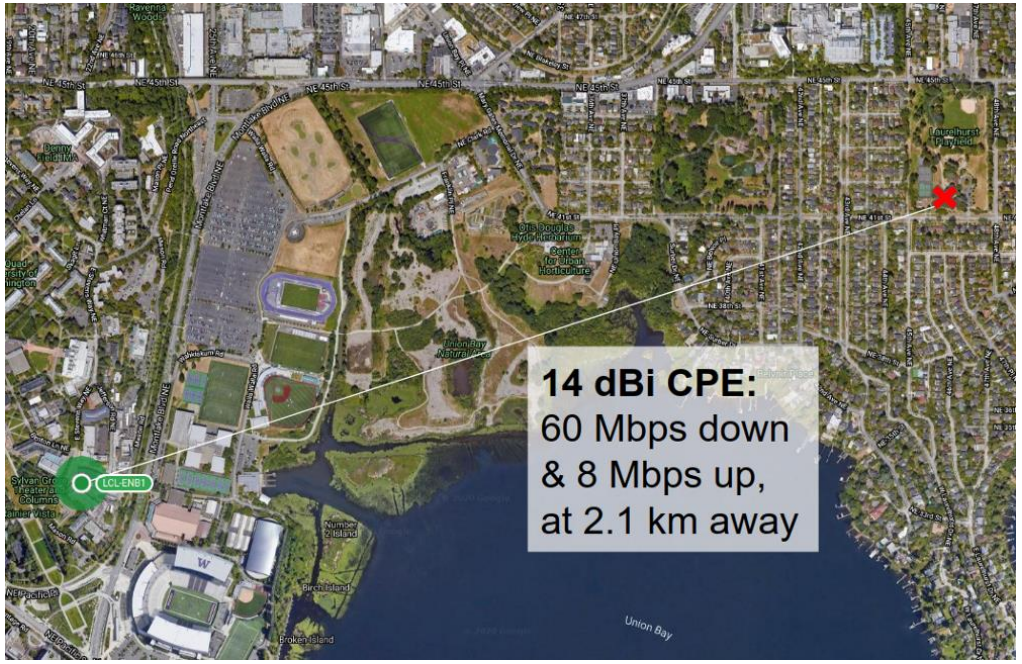
6. Local Connectivity Lab

- Non-profit partnering with UW to increase free/low-cost broadband access in higher-need areas throughout the city
- Makes use of existing UW and city network infrastructure such as buildings and fiber-optic cables to extend coverage
- 4G LTE networks, powered by open5gs, operating in the Citizen's Band Radio Service frequency spectrum (band 48)

Test LTE network on UW campus

6. Performance Measurement App

- BaiCells Nova 233 CBRS basestations can support 96 simultaneous users with a peak bandwidth of 116 Mbps per link
- Project goal: measure network performance over time, especially how it changes with more users and under backhaul saturation
  - Potential for gamification
  - Report to a server
  - Some level of anonymity to protect privacy
- Skills: Android app development; user interface design



Early example: Line-of-sight performance of LTE test network at UW, with Baicells 14 dBi Consumer Premises Equipment receiver.

7. Red Cross Data Reporting Tool

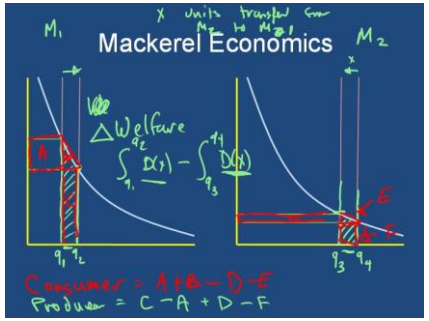
- UW has collaborated with IFRC to develop RC2, and ODK-X app for disaster response
  - https://media.ifrc.org/ifrc/rc2-relief-tool/
- Mobile application for tracking distribution of aid
- Challenge in making use of the data and customizing reporting during field deployments
- Project would develop user-configurable system to process system information

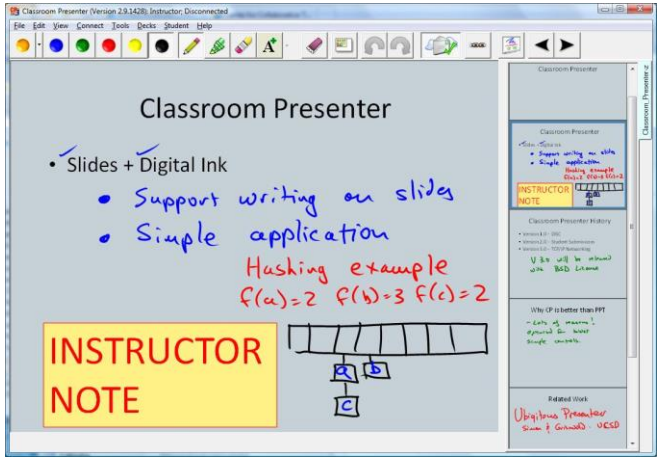
My background

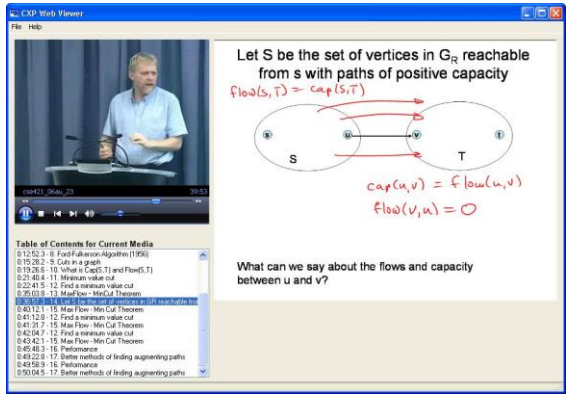
- PhD, Stanford (1985)
  - Thesis: *The Complexity of Parallel Algorithms*
- Post Doc (1985-86) Mathematical Science Research Institute, Berkeley
- University of Washington (since 1986)
  - Broad range of work: Algorithms, Software Engineering, Educational Technology, Computing for Development
- Sabbatical 1993-1994
  - Indian Institute of Science, Bangalore
  - Parallel Algorithms
- Sabbatical 2001-2002
  - Microsoft Research, Redmond
  - Learning Science and Technology
- Sabbatical 2008-2009
  - PATH, Seattle
  - Digital Health

Distance Education (2001-2008)

- Sabbatical at Microsoft to develop ConferenceXP technology
  - Basis of UW PMP Distance Learning
  - Multisite courses including UW-Redmond-Pakistan
- Tablet PC Technology
  - Classroom Presenter
  - Interactive Classroom Activities

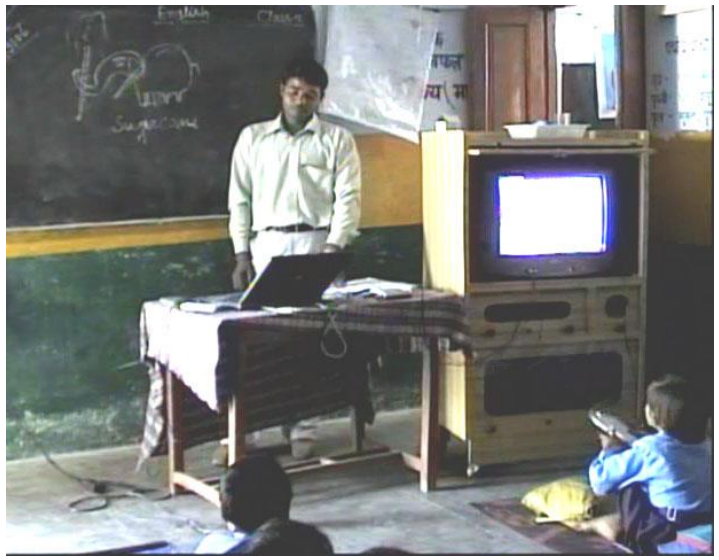


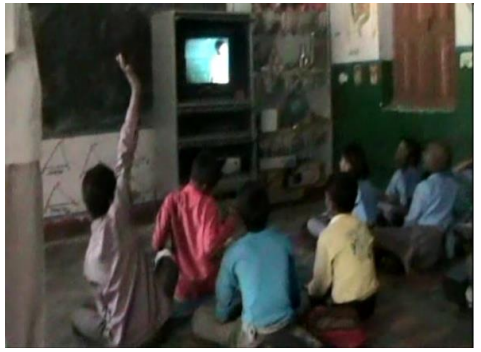


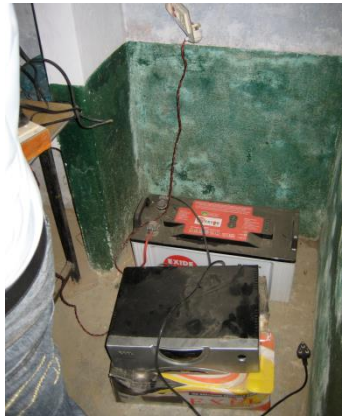


Digital StudyHall (Lucknow, India)

- Tutored Video Instruction Pedagogy
- Target: Rural schools in India
- Model
  - Lesson videos recorded at hub school
  - Training of facilitators
  - Facilitation model
  - Cost realism in technology deployment

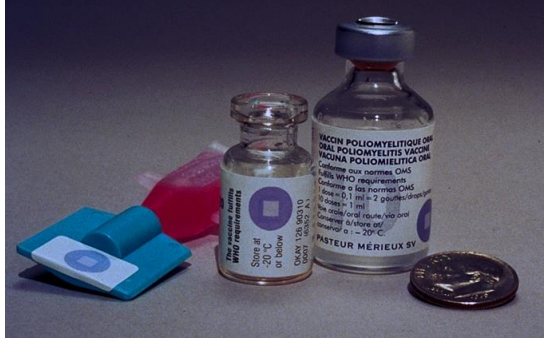


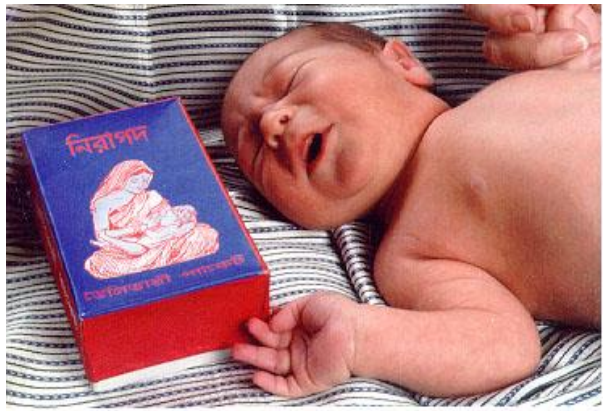




Digital Health at PATH

- Global Health NGO Based in Seattle
  - Development of health technologies
  - Global advocacy
  - Implementation of global programs
- Increased emphasis on Digital Health
  - Promotion of Global Good software



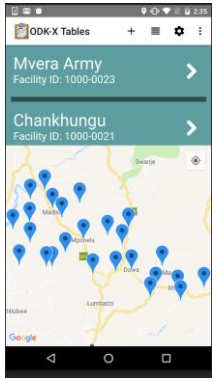


Projecting Health

- Video based education in Health
- Implementation with PATH
- Community created video content
- Facilitated showing in Mothers' groups
- Broad range of health messaging
  - Maternal Health
  - Immunization
  - Family Planning
  - Infectious diseases
  - Sanitation

Open Data Kit

- Digital Data Collection on Android Phones
- Launched by Gaetano Borriello (2008)
- Took over project in 2014
- ODK 1.0 Forms based data collection
  - Spun out as independent Open Source Project
- ODK-X Mobile Data Management
- Multiple current projects in immunization and with International Red Cross



Digital Financial Services

- Project with BMGF
- Funded to investigate technological challenges to adoption of Digital Financial Services
- Project Areas
  - Security and Fraud
  - USSD Technology
  - Technological Inclusion
- Established center in Lahore, Pakistan

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Improved access to financial services is critical for raising people out of poverty

Cold Chain Information System

- Track information about country vaccine cold chains
  - Status of vaccine refrigerators and cold rooms
- ODK-X Application for immunization logisticians
- Dashboard for country managers
- Deployment in multiple countries with Gavi and WHO