

Development Engineering

CSE 590 B

Course Overview

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Today

- Development Engineering Overview
- My background
- Course Mechanics
- Development Engineering
- Some background
- Topics

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

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



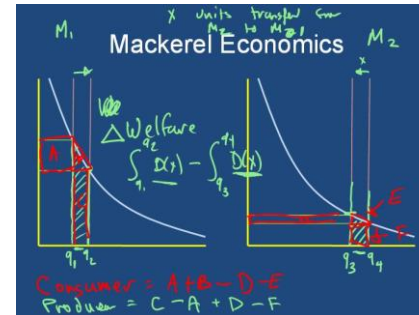
CSE

Microsoft®
Research



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



Classroom Presenter

- Slides + Digital Ink
 - Support writing on slides
 - Simple application

Hashing example
 $f(a)=2$ $f(b)=3$ $f(c)=2$

INSTRUCTOR NOTE

Let S be the set of vertices in G_n reachable from s with paths of positive capacity

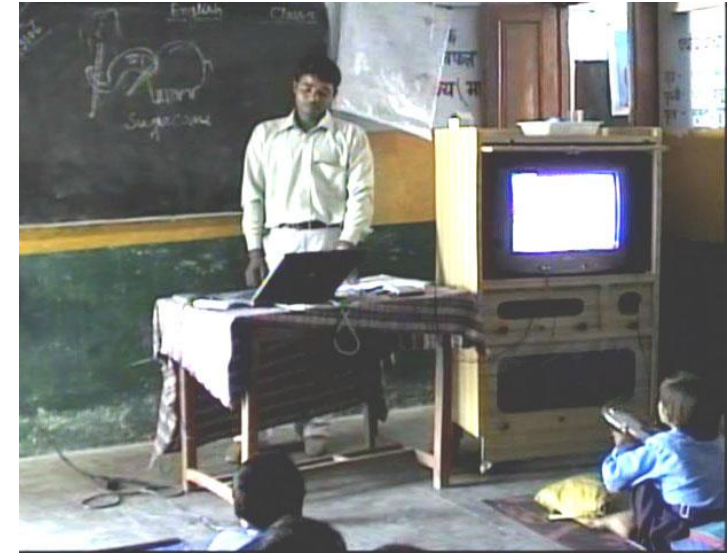
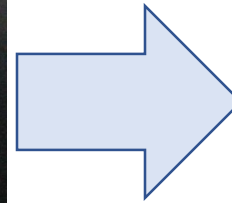
$flow(s, T) = cap(s, T)$

$cap(u, v) = flow(u, v)$
 $flow(v, u) = 0$

What can we say about the flows and capacity between u and v ?

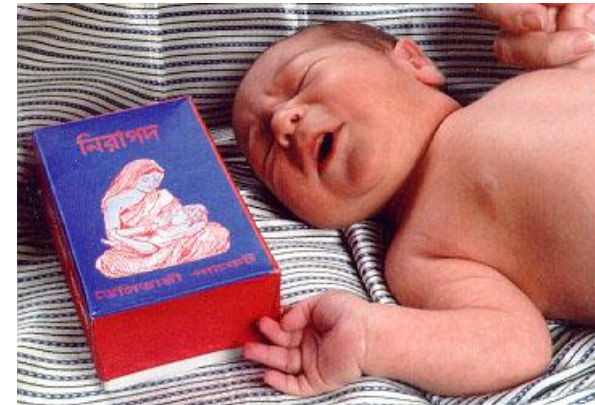
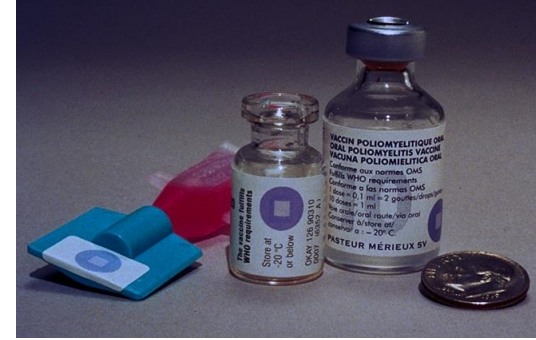
Digital StudyHall (Lucknow, India)

- 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



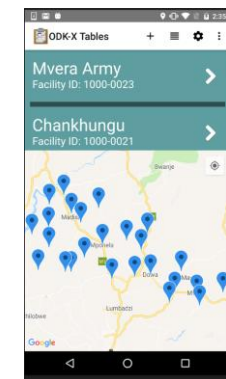
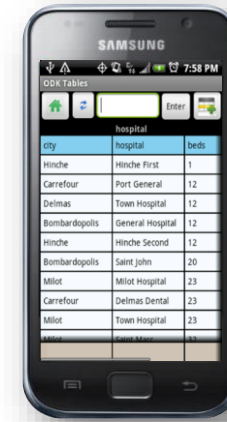
Projecting Health

- 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 IRC



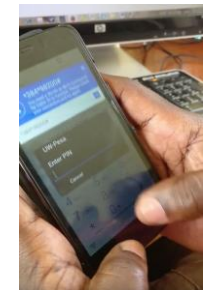
Digital Financial Services

- 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

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



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Course objective

- Prepare students to take on Development Engineering job assignments
 - Work on a product with Development Engineering applications
 - Take a job with an organization doing Development Engineering
- General skills: Global engineering

Course mechanics

- Weekly presentation / discussion (2 hours)
 - This is not a format I am familiar with, so we will have to figure it out
- Discussion sections (1 hour)
 - Smaller group discussions
- Weekly readings
- Weekly assignments
- Course grade will be based on 7 of 9 assignments.
 - This is done to allow flexibility for travel and deadlines

Development Engineering

- Post world war two development agenda
 - Substantial resources to global economic development
 - Establishment of global organizations: UN, WHO, WorldBank
 - Tied to East-West conflict and decolonialization
 - Development = Expertise + Resources
- Global development has been uneven
 - Many academic fields attempt to understand development
 - Understanding of process
 - Recognition of markets, local control, capacity development, partnerships
 - Development has divided into domains
 - With periodic pushes to break down silos and support cross-cutting programs

Engineering Focus

- This course will focus on appropriate technology
- Recognition that technology is only one component, and that there are challenges outside of the scope of technology
- Recognition that there are risks with technology, and that technology can have negative consequences
- However, there are many global problems that can be addressed by technological interventions
 - Where, to the first order, it is a good thing to do

Constraints I

- Financial:
 - Targeting a radically different price point
 - Different trade offs between labor and technology
- Infrastructure:
 - Network access and bandwidth
 - Electricity access and quality
- Technology:
 - Different types of devices
 - Different modes of device access
 - Limitation on device access
- Education
 - Different levels of literacy
 - Technological capacity

Constraints II

- Language
 - Multilingual
 - Low-resource languages
- Market Limitations

Design and Development Process

- Many different models
 - Come up with an idea
 - Flesh out the idea
 - Build a prototype
 - Build a better prototype
 - And another prototype
 - Engineer the system
 - Initial Deployment
 - Fix the system
 - Bigger deployment
 - Production release
 - Promote broad adoption
 - Keep the product running

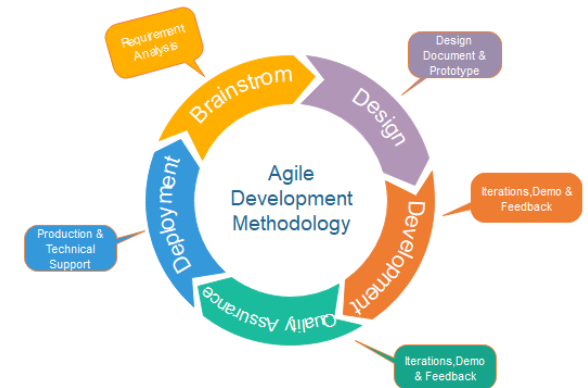
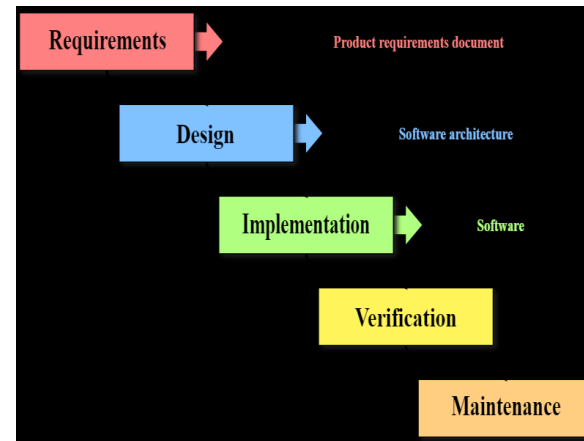
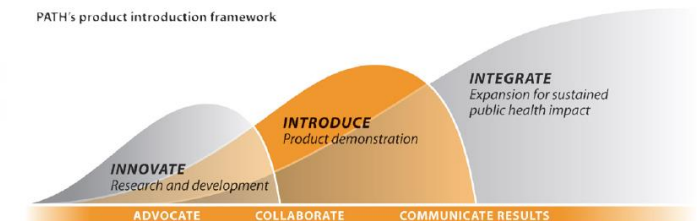
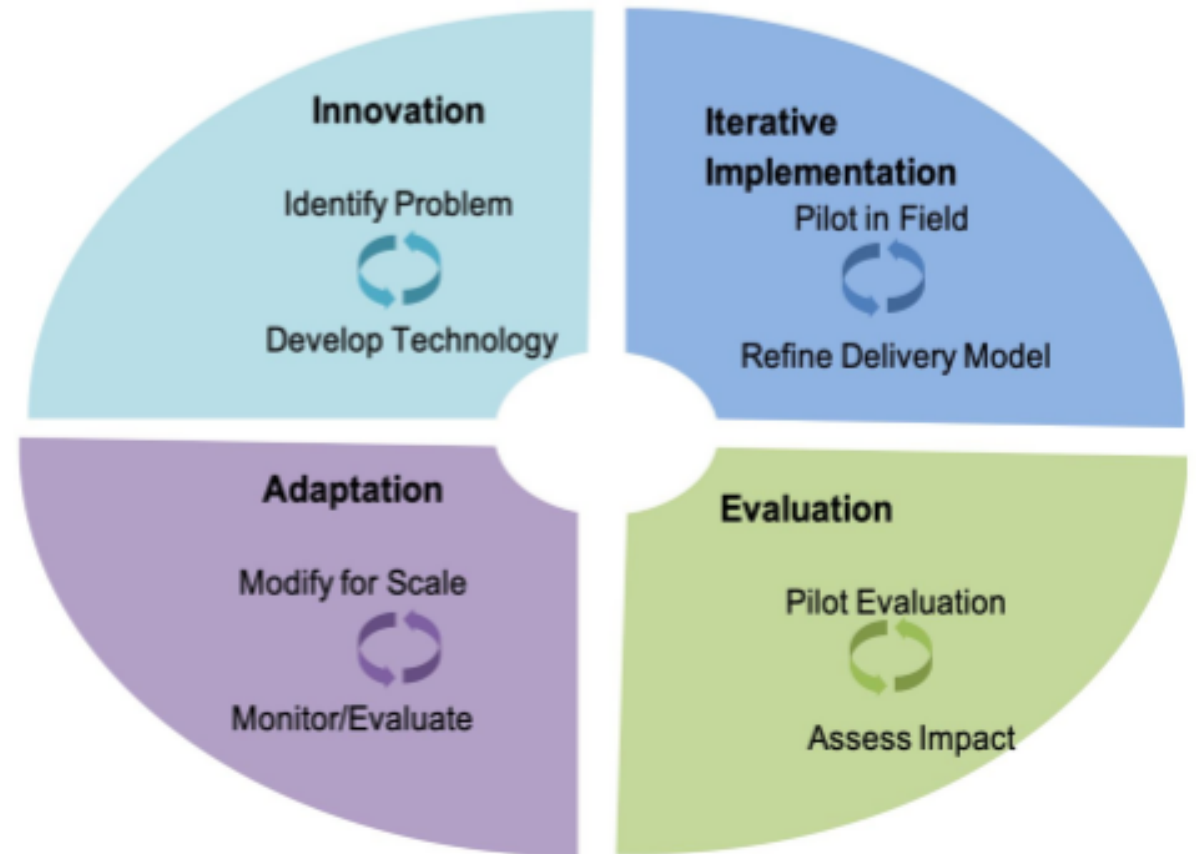


Fig. Agile Model



Framework: Research Workflow

1. **Innovation:** Ask the right questions.
Hypothesize the solution.
2. **Iterative Implementation:** Learn, fail,
pivot
3. **Evaluation:** Rigorously test the
mechanism of impact
4. **Adaptation:** Understand context and
generalize



Framework: Mechanisms for Impact



Productivity of Labor & Capital

- Advances in resource extraction, processing, delivery drive productivity
- Disruptive technologies may require large investments in retraining and retooling

Human Capital

- Innovations in healthcare and education can improve targeted outcomes
- Impacts on human capital and productivity are often untested

Infrastructure & Amenities

- Advances in transportation, air quality, housing, sanitation are key for transformation
- It is difficult to attribute technology's contribution to the "enabling environment"

Markets

- Market structure can shift rapidly due to improved linkages
- Reduction in information asymmetries and transaction costs drive adoption

Governance

- Increasing transparency and accountability to citizens
- Effectiveness of public service delivery and regulatory enforcement (State capability)

Social Networks, Norms & Aspirations

- Changing connectivity and information flows within and across communities
- Updating or enforcing social norms, altering aspirations

Sustainability

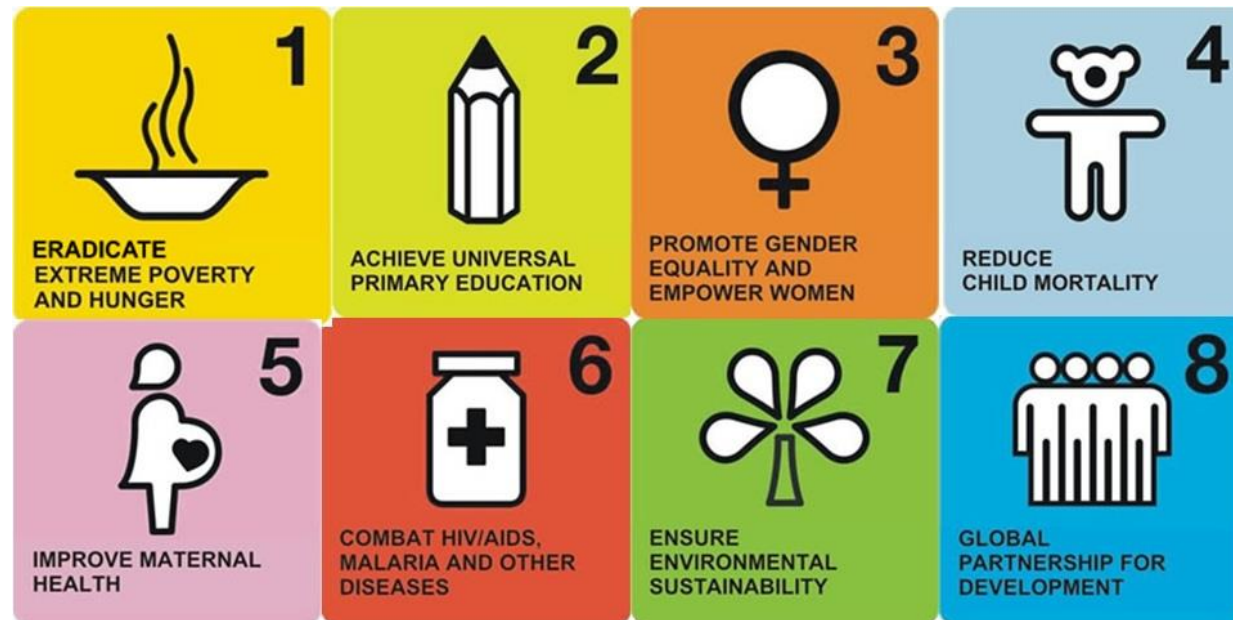
- Critical issue is achieving long term impact
- Field is criticized for too many pilots
- Some projects should go no further than the pilot stage
 - Not a good idea
 - But identify learnings
- Sustainability
 - Requires a business case, or market, or some means of keeping things going
 - Domain is not necessarily market driven
- Product life cycle
 - Requires consideration of the entire product life-cycle

Covid-19

How has the world changed since Jan 21, 2020?

Millennium development goals

- International development goals established by United Nations in 2000
- Targeted results by end of 2015



Millennium development goals

1. To eradicate extreme poverty and hunger
2. To achieve universal primary education
3. To promote gender equality and empower women
4. To reduce child mortality
5. To improve maternal health
6. To combat HIV/AIDS, malaria, and other diseases
7. To ensure environmental sustainability
8. To develop a global partnership for development

Sustainable Development Goals

- New global goals through 2030
 - 17 Goals with 169 Targets



Sustainable Development Goals

1. End poverty in all its forms everywhere
2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture
3. Ensure healthy lives and promote well-being for all at all ages
4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
5. Achieve gender equality and empower all women and girls
6. Ensure availability and sustainable management of water and sanitation for all
7. Ensure access to affordable, reliable, sustainable and modern energy for all
8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
10. Reduce inequality within and among countries
11. Make cities and human settlements inclusive, safe, resilient and sustainable
12. Ensure sustainable consumption and production patterns
13. Take urgent action to combat climate change and its impacts
14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development
15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
17. Strengthen the means of implementation and revitalize the global partnership for sustainable development

Global Technology and Development Stakeholders

- Global Organizations
- Donors
- Implementing NGOs
- Research Establishment
- Technology NGOs
- Tech Industry
- Government
- Local NGOs and Civil Society



Global

- World health organization
- UNICEF
- GAVI
- FAO
- World Bank



Donors

- Bill & Melinda Gates Foundation
- USAID
- DFID
- GDZ
- NORAD

BILL & MELINDA
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Implementing NGOs



Research establishment

THE EARTH INSTITUTE
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Technology NGOs and Social Enterprises



DATADYNE
We get data.

