

# Week 1 (Jan 4 — 9)

## we we invest in economic development

- our economic wellbeing is built upon exploitation in low-income countries
  - lead recycling in nigeria linked to extensive lead poisoning
  - uman and environmental costs associated with cobalt mining in the DRC
  - barrick gold staff engage in systematic sexual violence and killings in papua new guinea

## where do we go from here?

training engineers to be effective global citizens

1. learning the role of technology
  - a. engineers feel a responsibility to contribute to the efforts to end the unjust and unequal distribution to basic services such as WASH, energy, food, transportation, and shelter
  - b. our weapon of choice is technological innovation
  - c. but it doesn't always work

## drivers of tech skepticism in the global south

- cia fake vaccination campaign in pakistan
  - collected dna to find bin laden
  - increased vaccine hesitancy resulted in delayed polio eradication
- free basics facebook pilot in india
  - program offered free access to a limited version of internet for people who couldn't afford data
  - faebook created a walled garden which gave them power to act as gatekeeper for what poor folks could see online
  - india banned the service in 2016
- sam altman and the scanning of irises for crypto — worldoin
  - project cofounded by sam altman to offer people in kenya free money (in form of crypto) to scan their irises
  - targeted economically vulnerable people who didn't understand technology or data privacy implications
  - kenyan government eventually suspended worldoin



worldoin reinforced this narrative that the Global South is seen as a testing ground for surveillance technologies that Western populations might reject or regulate more strictly

## colonial historic barrier

- legacy of
  - weaponizing tech against people in low-income countries
  - unfair trade and debt terms imposed on the developing world
  - flawed technology implementation and transfer from wealthy to low income countries
  - haiti is a good example — france and spain splitting the island in two, each country treated it very differently in the past and they turned out to be very different countries
    - austerity programs and haiti had to pay reparations to france for some reason

## realize the inequalities within engineering

- 90% of the worlds engineers design products for the richest 10%

## syllabus overview

- monday lectures will go for the full 2 hours
- wednesdays will be a guest speaker or workshop for usually one hour
- grades
  - midterm 25
  - final 35
  - assignment 1 20
  - assignment 2 15
  - participation 5
- assignment 1 — leverage rich time series data to learn about global development — individual
  - use the world bank development indicators to extract large datasets, produce visualizations, and answer questions
  - will require some basic knowledge of a high level programming language such as R, python, or matlab
- assignment 2 — debate — group
  - use the material and verbiage you learned from the course to engage in a structured debate around contentious questions in global development
  - each team is assigned a case study and designated to argue in favour of a certain position of the topic
  - teams must submit their research notes on the topic, specify how they will prepare for the debate and assign one or two debaters
  - teams will square off in a debate (1 team vs 1 team) at the end of the term

- participation — the name card thing

# Week 2 (Jan 12 — 16)

## Readings

### what is global engineering?

- in past 2 centuries almost every country has made progress in development
- heavy geographic correlation between country's state of development and its location (kinda obvious)
- in 2012 over \$2 trillion was transferred from richer to poorer countries
- financial outflows, debt interest payments, WB/IMF loans undemocratically imposed, corporate profits, capital flight all to be blamed for continuing poverty of those countries.
- \$3 trillion actually flows from poorer to richer countries every year

### 1.3 the engineer in the past

- first major infra projects were after WWII in former colonies, however these came apart after the 1970s
- pivoted towards smaller scale engagement
- question about quality/ecological impacts of local solutions vs imported ones
- underrepresentation of engineers from low- and middle-income countries who have a different perspective

### 1.4 the engineer of the future

- would benefit from considering global trade imbalances, resource exploitation, unequal distribution of wealth, etc.

## Lecture

### reading summary

- that poverty can be solved through poverty or people is a conceit
- there are historical and structural inequalities that still hold people down
- low income countries are net creditors to rich countries
- evolution of engineering involvement in development
  - top down infra → small is beautiful
  - assume tht emerging economies are either not entitled to or not capable of benefitting from the same tech as the countries providing development advice
- engineers must consider the historical and present causes of persistent poverty instead of perceiving poverty as a stage of inevitable growth

## the past 10000 years

- global population
  - in 8000 BC there were only around 5M people
  - in 0 BC we had 300M people
  - in 1800 CE we hit 1B
  - then in just 130 years we hit 2B
  - another 30 years later (1960) we hit 3B
  - 4B in 1974
  - 5B in 1987, 6B in 1999, 7B in 2011
  - now at 8.2B
- thomas robert malthus — concerns about overpopulation
  - idea that food supply was growing linearly but the population was growing exponentially
  - fear that people would live off subsistence
  - "Malthusian catastrophe"
- hysteria in the 20th century
  - paul ehrlich's *the population bomb* in 1973
  - published after a visit to New Delhi
  - thought that the world's resources are being wasted by the poorer peoples of the world
- another book: *road to survival* took another swipe at indians
  - said the flow of money and aid allowed indians to "breed with the irresponsibility of codfish"
  - said world will hit a natural limit and then collapse
- one child policy in china and forced sterilization
  - had its own issues — don't want a top-heavy population
  - sex-selective abortions

## the green revolution

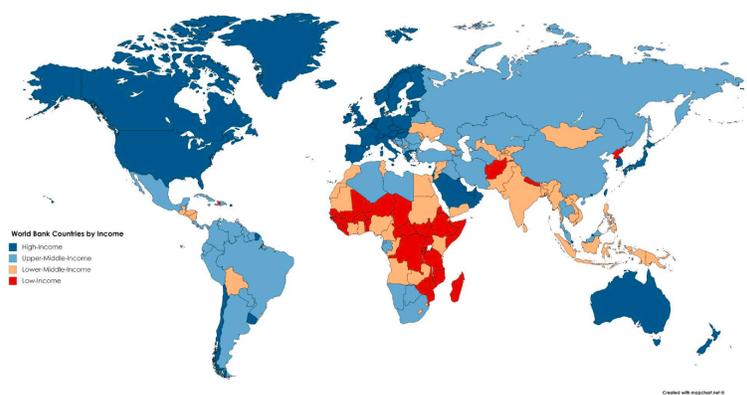
- haber-bosch process — allowed fertilizer production from nitrogen out of thin air
- tractors became less expensive
- high yielding varieties of cereal crops — note this is not GMO just very selective cross-breeding
- aquaculture — fastest-growing food sector in the world
  - world fish — genetically improved farmed tilapia (GIFT)
  - fish cages allow for "cash crop" type growth of fish

## overpopulation concerns (again)

- a lot of people have a lot of kids because they are poor
- contraceptives — one thing that helped reduce fertility
  - in brazil, telenovellas helped to reduce fertility
  - images of successful, rich, happy women shown as desirable traits

## loaded terminology

- in 1952 french demographer alfred sauvy wrote of the three worlds
  - first world the west
  - second world the communist bloc
  - third world everyone else
  - because many countries in the third world were low income, they became synonymous
  - archaic term doesn't reflect the shifting socioeconomic realities of rich and poor countries
  - some activists even point to the 4th world
- can't call it developed or developing either
  - view is judgemental, depends on faulty metrics and doesn't make sense
  - investors might be discouraged from getting involved
- can't call it the global south either — ties to colonialism
- divide now is within countries more so than it is between countries
- world bank classification of the world



## poverty metrics

### economic metric #1

- GDP — gross domestic product

- GNP — gross national product
- both are macroeconomic measures
- no consideration for black markets — in nigeria 40% of the economy is considered lack market activity

## **economic metric #2**

- the poverty line
- absolute poverty line — a threshold which is fixed in time and across countries below which one cannot satisfy their basic life necessities
- international poverty line is set at \$3 USD per day

## **shortcomings of the economic view**

- doesn't account for social views — crime, HIV/AIDS, pollution
- massive informal economies in low-income countries
- growth helps reduce absolute poverty but has little impact on relative poverty
- is inequality an inevitable part of growth?

## **measuring inequality: gini scale**

- 0-100 scale (0 is perfect equality, 100 is extreme inequality)

## **human development metric #1**

- HDI — human development index
- life expectancy, education, and GDP indices
- can also break this down by gender, called GDI

## **four income levels**

- extreme or low poverty — < \$3 per day
- middle income — 3 to 10 is L2, 10 to 40 is L3
- high income is >\$40 per day

# **wednesday lecture — guest speaker: joseph wong**

## ***healthy democracies* redux**

- hot takes (2004)
  - democracy matters
  - universal social insurance models are replicable

- political window of opportunity
- cold realities (2024)
  - labour market flexibilization
  - rising inequality
  - demographic transformation
- jd vance-ification of politics like happening in the US
  - “david rueda” in the presence of insider-outsider conflict, there is a strong temptation for social democratic governments to implement inegalitarian policies
- taiwan — rich country with universal healthcare
  - indigenous men live 10 years fewer — why?
  - followed a mobile health unit, found that mountains really get in the way
  - how do we get social services to people that are hard to reach
- we find that statistical national successes are masking moral and practical failures
  - people get left behind simply because they live in rural communities or urban slums, in conflicts zones, as part of indigenous groups, with disabilities, or because they are girls
- some more examples
  - cash transfer program for bottom 20% in brasilia
  - vaccine cold chain in some african country
  - orange and vaccine distribution in the northern communities of ontario
  - micro carbon credit initiatives in kenya
- the challenge in reaching hard-to-reach populations is not an intervention one but a systemic one — we need to rethink systems and institutions
- how to “theorize” reach
  - economics of reaching the hard to reach
    - exploding marginal cost for 100% reach, even if average cost remains low
  - making the political case
    - different constituencies even within an electorate broadly supportive of the social democratic role
  - scaling for the margins, replicating for scale
    - rooted, replicable, sustainable, add diversified value

# Week 3 (Jan 19 — 24)

## readings

### jeffrey sachs — the end of poverty

- extreme poverty is primarily caused by poverty traps, not bad choices
- poor countries cannot escape these traps without a large, coordinated big push of aid
- targeted investments in health, education, agriculture, and infra can trigger self-sustaining growth
- rich countries have a moral and practical obligation to fund these interventions
- with sufficient political will and resources, ending extreme poverty is achievable

### william easterly — the white man's burden

- foreign aid often fails because it relies on top-down "planner" approaches that ignore local realities
- aid agencies lack accountability, leading to waste, corruption, and ineffective projects
- poverty is not solved by grand plans but by bottom up searcher solutions driven by incentives and feedback
- external actors cannot easily engineer development, institutions and incentives matter more than money
- aid should be limited, experimental, and accountable, not ambitious and centralized

## monday lecture — poverty in context

- extreme poverty rates have been decreasing for the past decades
  - until 2018/2019 we were on track to eradicate by 2030
- disaggregating the data masks failures
  - gender gap — women and girls more likely to be poor
  - rural poverty
  - conflict trap — in stable countries, poverty is falling, but same can't be said about the conflict-affected countries

## poverty trap

- self inflicted cycle of poverty causing more and more poverty
- how do we know if someone is trapped in poverty?
- linear capacity curve is not realistic for anyone

- for regular workers we see its more log shaped
- for workers in poverty its a logistic curve

## diseases of poverty

- malaria
- tuberculosis
- HIV
- obstetric fistula — ashamed young women who have kids early
- noma — caused by severe malnutrition and poor hygiene

## summary

- starting income matters — capacity curves
- external aid is essential to dislodge people from poverty traps
- economists disagree on whether poverty traps exist

## what is "aid" exactly?

### development aid

- also called official development assistance
- financial aid given by govts and other agencies to support economic, environmental, and social development of LICs
- distinguished from humanitarian aid by focusing on long term
- bilateral (~70%) and multilateral (~30%)

### aid funding for innovation

- grand challenges canada
  - integrated innovation model at the intersection of tech social and business innovation
  - use a tiered funding approach
- global innovation fund
  - innovations that have the potential to reach millions of people living on less than \$5 a day

## problems with development aid

### #1 sheer lack of money

### #2 fungibility of aid dollars

- if a country had set aside 1B for something, but they receive aid, then where are they going to spend the extra money?
- we can't guarantee they'll spend it on what we want to spend it on

### #3 limited absorptive capacity of recipient countries

- new philosophy called tied aid — comes with a stipulation that it must be spent on goods from the donor country

### competing contemporary theories on aid

- pro aid — end of poverty by jeffrey sachs
- against aid — the white man's burden by william easterly
  - aid fails because its implementation is unaccountable to its beneficiaries
  - aid creates perverse incentives for its donors



aid is not binary: when it works and when it doesn't

### case study 1: unexpected findings in kenya

- 90s, ratio of students to textbook is 17:1
- ngo distributing to students partnered with MIT economist, did a randomized control study
- deworming pills:
  - group that got pills saw immediate disease transmission, healthier households
  - for pills that cost \$1.36, saw 20% growth in lifetime earnings
- lots of low hanging fruits like that
- and yet:
  - parents won't give kids deworming pills
  - households don't buy fortified foods
  - in india immunizations as low as 5%
- bigger improvements when there are immediate rewards instead of long term gains
- ultimately, the poor suffer from the same problems that afflict everyone when it comes to making the right decisions:
  - lack of information/disinfection
  - weak beliefs
  - procrastination

### case study 2: birth control in kenya

- concerned with high teen pregnancy in the 90s
- coincided with relatively high national fertility
- marker of unsafe sex which creates HIV risk
- obvious solution is to make birth control more available:
  - that doesn't lead to lower fertility
- four other attempts
- key symptoms: pressure to find someone to take care of girls, finding them a sugar daddy
  - older men causing a lot of these teen pregnancies

## takeaways

- aid that assumes the poor will do the right thing is misguided
- the poor don't have perfect information and have to make a lot of difficult decisions on the fly
- poor can be victims of laziness and boredom
- poor are extremely risk averse
- aid only works when proper governance exists with strong accountable institutions that have the political will to act
- markets for life-improving products and services don't exist in LICs

## probing into nutrition trap question

- why are the poor eating less?
  - people are generally healthier
  - decreased intensity of physical labour
- other wrinkles:
  - food expenses represent 58% of consumption among rural extreme poor, 64% among urban extreme poor
  - in a Chinese experiment, when rice is subsidized, demand paradoxically went down
- hunger remains rampant in conflict zones
- millions of adults are undernourished (hidden hunger)

## what to make of all this

- poor make thought-out decisions on nutrition
- so why not make better decisions?
  - many poor have value systems that emphasize spending on social occasions
  - life in rural villages can be extremely boring



# Week 4 (Jan 26 — 30)

## slides title

### crash course: foundations of colonialism

- environmental, anthropological, and geographic factors set the stage for the different development trajectories between Europe and Africa
  - Eurasians had more plants/animals capable of domestication
  - eurasia's large landmass and east-west orientation enabled rapid diffusion of innovations
  - food supply enabled eurasian societies to specialize and develop novel tools and weapons
  - developed immunity against diseases spread from animals
- wealthy societies developed everywhere but europeans developed better gunpowder and brought infectious diseases with them
- by the late 1800s, europeans had colonized large territory in many continents but not africa — because of **malaria**
- malaria is predicted to have killed 5% of all humans that have ever lived — extracted quinine from the cinchona tree bark
- european colonists turned african countries into raw-material factories
  - modern day nigeria was once called a royal niger company
  - sold nigeria to the british govt for \$100M
- infrastructure and tech brought by the europeans only served colonial interests
  - the kenya-uganda railroad
  - divide and conquer strategy strengthened by these railroads

### harry truman tries to fix the problem

We must embark on a bold new program for making the **benefits of our scientific advances and industrial progress** available for the improvement **and growth of underdeveloped areas**. More than half the people of the world are living in conditions approaching misery. Their food is inadequate. They are victims of disease. Their economic life is primitive and stagnant. **Their poverty is a handicap and a threat both to them and to more prosperous areas**

- said by harry truman in his inaugural address in 1949. "point four program"

# evolution of development paradigms

## WWII — mid 70s

- postwar order
- emergence of benevolent development
- pig push development model
- driven by engineers

## Mid 70s — Late 80s

- neoliberal economics
- washington consensus
- structural adjustment programs
- driven by economists/austerity/privitization

## Late 80s — Early 2000s

- instituionalization of development
- poverty reduction strategies
- MDGs, SDGs
- driven by social scientists

## 2000s Onwards

- capacity building
- self-sufficiency
- appropriate technology
- more driven by cross-disciplinary

## Post WWII Reconstruction

- Marshall Plan
  - \$13 billion aid package by US to help Western Europe after WWII
  - lasted 4 years
  - investments in industrialization
- World Bank/IMF established at Bretton-Woods Conference in 1944
- UN and GATT established a year later (GATT became the WTO)

- Universal Declaration of Human Rights in 1948

## development pioneers: rostow

- modernization theory
- development is an evolutionary process over 5 stages
- based on growth blueprints followed by rich countries in the previous century
  - (1) traditional society — subsistence
  - (2) preconditions for take-off — some brave souls
  - (3) take-off — from tractors to textile mills, people start leaving farms
  - (4) drive to maturity — the rich start investing into infra
  - (5) age of mass consumption — economy becomes service-driven, more socialist services, life abt lifestyle/choice >
- described how the global south overcame their barriers to prosperity
- foreign aid is crucial to overcome those barriers

## development pioneers: rosenstein=rodan

- architect of the pig push model
- growth requires large scale investment in all sectors of a developing economy
- focus on infrastructure, manufacturing, and trade
- neglects cultural considerations and impact of colonization, ignores agriculture, and social reforms
- "Launching a country into self-sustaining growth is a little like getting an airplane off the ground"
- **"negative social value"**

## problems with modernization theory

- is a eurocentric model — looked down on other cultures
- focusses on GDO as only proxy for development
- neglects causal and historical factors which hindered development in the first place
- resulted in white elephant projects
  - cost more to maintain than generate in value
  - e.g. kariba dam in zambia

## second era: 70s — 90s

- trickle down economics
- gave rise to something called dependency theory

- development of global north founded on exploitation of the south
- resources flow from periphery to the core and have to buy back goods at a cost greater than that of the resources
- rejects modernization, says backwardness is not caused by internal factors but rather by the exploitative actions of rich countries
- proposed solution: global south should embark programs of **import substitution industrialization** so that they can shed their dependency on rich countries

## **rise of globalization**

- dependency theory was never fully translated into practical policy recommendations that could be followed by governments and international agencies
- nevertheless some countries managed to break into labour-intensive manufacturing and global trade
- foreign investments rose substantially but...
  - so did national debts of LICs
  - numerous economic crisis in the 80s

## **washington consensus**

- neoliberalism became a dominant ideology in the 80s
  - favoured reduced government involvement in economic development activities
  - focussed on open-trade, trickle-down policies
- those policies were collectively referred to as structural adjustment programs
- those programs were promoted by
  - IMF
  - World Bank
  - US treasury
- referred to as the Washington consensus

## **structural adjustment and debt**

- the african debt trap
  - throughout the 80s, african got dealt a series of unfair trade terms that resulted in trade imbalances
  - foreign aid increasingly took on the form of loans and not grants
  - corruption led to wasted financial resources
  - loan repayment resulted in reduced govt spending on welfare and economic development
- Chinese development banks starting to impose stringent debt terms on some LICs

- happening more so today
- Maldives and tonga are likely to default on their detbs

## **third era: 90s to 2000s — institutionalization, pro-poor growth and social science**

### **transition to inclusive growth**

- contemporary view
- more direct focus on poverty reduction would lead to virtuous cycle od poverty reduction + growth
- sustainable livelihoods approach
  - holistic participatory approach to poverty alleviation
  - works directly with the poorest people to help them build on their strengths
  - build social capital
- develop pro-poor markets which take into account the historic barriers facing LICs

### **focus on development as freedom**

- economic development entails a set of linked freedoms
  - political freedom and transparency
  - freedom of opportunity
  - economic protection
    - income supplementation
    - unemployment relief
    - social safety net
    - free markets
- focus on expanding the freedoms of people at the base of the pyramid

### **millennium development goals (MDGs)**

- 8 intl development goals adopted by the UN in 2000
- deadline was 2015
- uneven progress



## sustainable development goals (SDGs)

- replaced the MDGs in 2015 as part of the 2030 agenda
- most ambitious push to date
- 17 goals, 232 indicators



## role of civil society and NGOs

- ngos can channel development aid better than bilateral agencies
  - they can be specialized
  - strong local connections
  - more trustworthy than potentially corrupt govt officials
  - more cost-effective
  - nGOS can act in consortia

## summary

- the poor make thought out decisions which we would only understand if we study the systems they live in

- the poor suffer from the same shortcomings as us: procrastination, weak beliefs, and lack of information
- countries in the global south were systematically exploited with no effort to development their societies and economies
- colonial borders result in conflict and limit transfer of tech and ideas
- the end result is persistent, intergenerational poverty, and corruption which requires systemic solutions to address

## guest lecture — the “resource guide”

### how can mining contribute to sustainable development?

- job creation, community development, boosting local economy
- taxes/royalties
- raw materials and shared infra
- critical minerals
- philanthropy + investment in remote areas
- community development  $\neq$  philanthropy necessarily

### why is mining important to Canada

- 5% of Canadian GDP, 1 in 26 jobs in Canada are in mining
- 40% of the world’s mining and exploration companies are listed on the TSX and TSX Venture Exchange in 2023.
- accounted for 19% of Canadian exports

### Paradox of plenty

- concept that countries rich in natural resources often experience slower economic growth, weaker institutions, and worse social outcomes than other countries
- how does it manifest?
  - exploitation, corruption, political instability
  - conflict, criminal enterprises
  - lack of diversification, boom & bust exposure, widening inequality
  - broken ecosystems and environmental contamination

### grassy narrows NW ontario canada

- company dumped mercury waste into a river
- FN group heavily depended on the river for their livelihoods

- up to 90% of population experiences some form of mercury poisoning — neurological damage

### **bisha mine, nevsun resources in eritrea**

- high risk mine in a high risk environment
- 2014, case brought to BC court on allegations of forced labour
- usually we see govts own some part of the mine or mine uses govt contractors
  - in this case it was the govt contractors doing the abuse so nevsun denied and feigned responsibility
  - settled out of court

### **fenix mine, hudson bay minerals, Guatemala**

- decades of environmental damage, led to civil wars, etc
- charges of murder, rape, assault, forced displacement
- case brought before the Ontario superior court
- settled out of court

### **porgera mine, barrick gold, papua new guinea**

- very large indigenous population
- charges of murder, gang rapes, sexual torture, tailings discharges, artisanal mining, use of mercury
- made the headlines almost everywhere — human rights watch made a report condemning them
- settled out of court — 112 women got compensated but the details got leaked
- artisanal mining — aka illegal mining, small-scale mining done by individuals

### **vale, brumadinho tailings disaster, brazil**

- catastrophic tailings dam failure built in 1976, not used since 2014, the dam breached and 270 got killed

# Week 5 (Feb 2 — 6)

## guest speaker yu chen — “transdisciplinary approach to enhancing community sustainability and resilience”

### ethnographic research

- ethnographic research involves sustained, immersive engagement in a social setting where the researcher observes, participates, and documents social interactions and cultural practices in order to produce an in-depth, contextualized understanding of how a people make sense of their world
  - prolonged field engagement
  - participant observation
  - contextualized understanding
  - iterative and inductive

### uoft — isla urbana campaign something

- investigating factors associated with the adoption of rainwater harvesting technology
- improving isla urbana’s capacity for user engagement, system monitoring, and impact assessment
- ensuring the safe management and treatment of rainwater while building local capacity for water quality testing
- studying community based water management to understand its strengths, challenges, and role as a key agent in implementing decentralized water initiatives
- facilitating knowledge exchange rainwater harvesting and community water initiatives among indigenous communities

### pilot research on household UV-LED rainwater harvesting

- effectiveness and performance of UV-LED over 24 months of operation
- peri-urban water quality challenges
- household usage, user interaction, and adoption
- economic feasibility

### study: knowledge mobilization on rainwater harvesting between indigenous communities in canada and mexico

- nipissing first nation delegates went to mexico to explore rainwater harvesting techniques in Mexico
- then two years later some mexican indigenous people came to Canada

## remarks on researchers' role in community-based ecotechnology initiatives

- adopting decentralized water infrastructure like rainwater harvesting represents a paradigm shift in governance
  - transitioning responsibility to individual households
  - shift can be beneficial and challenging
  - offers households greater autonomy but introduces significant risks
- tech appropriation is a crucial pathway to fostering collective agency and addressing environmental injustice
  - codevelopment of affordable sage and user friendly tools
  - assistance in training and community capacity building
  - translation of research findings into policy documents and guidelines

## when are social sciences relevant to engineering?

- human interactions w/ environment, infra, and tech global development
- project design and implementations
  - understanding community needs and **aspirations**
  - opportunities for project implementation
  - strategies for achieving positive long term impacts
  - emphasizing community wisdom over imposing external scientific knowledge or agendas
  - transcending technical aspects and frame problems in a way that reflects that social economic

## carrying an ethnographic mindset to community-based engineering research

- producing knowledge thorough interpersonal interactions
- positionality — positioning of researcher in relation to social and political context of the study — self-reflection ,community immersion
- power structure — local governance, decision making, resource allocation, conflict sensitivity
- politics of representation, ethics and reciprocity
- field notes and how to make sense of qualitative daa

## weekly reading notes

- young, privileged, and idealistic people are drawn to solve others' problems, especially abroad. because they seem simple and urgent, not because they understand the deep complexity involved.

- reductive means oversimplifying — seduction refers to how attractive those problems seem, easy, solvable. happens for three reasons:
  - distance from context — the farther you are from a problem, the easier and more solvable it feels
  - desire for meaning — young people want purposeful lives and are drawn to goals like “saving the world”
  - cultural encouragement — fellowships, nonprofits, conferences
- some problems with this seduction
  - oversimplification can harm people
  - it can displace local solutions
  - creates cultural and economic harm
- what the author encourages us to do instead
  - don’t focus on supposedly “solvable” problems
  - stay long enough to understand
  - work on problems to home too
  - love complexity not saviour roles
- summary — article challenges common assumption that development is easy and outsiders can “fix” problems without real context or deep engagement.

## wednesday lecture

- negative effects of voluntourism
  - save the children told people not to volunteer at orphanages
  - can’t do background checks, etc, people incentivized to traffic children to these orphanages
- people will travel there with hifi tech but just doesn’t work due to other factors
  - also why aren’t those people building it for themselves?
- e.g. playpump — well thought-out in theory
  - of 1500+ installed in zambia, 1 in 4 needed maintenance in 2 years
  - 100s were abandoned
  - project criticized for child exploitation



scenario: awarded an EWB fellowship to travel to Ghana to volunteer. plane leaves tomorrow, gone for a year

wrinkle: you’re forbidden from telling everyone  
do you still wanna go for it?

# week 5 content — technology and economic growth

## understanding economic output

- human capital ( $eL$ ) consists of labour ( $L$ ) and education ( $e$ )
- physical capital ( $k$ ) becomes GDP ( $y$ )
- $y \propto keL$

## schumpeter's method — creative destruction

- economic growth done by a new technology wiping out an older technology
- growth is accomplished through waves of disruptive tech innovation which create new economic orders while destroying older ones
  - M-Pesa mobile banking
  - M-KOPA financial inclusion
  - hello tractor
  - aravind eye hospital

gonna look at  $y \text{ prop } f(K)$

- solow model — physical capital
- assume economy is a farm
- diminishing returns on capital
- marginal cost increases and return needed to break even increases as well
- depreciation is linear with physical capital
- $I - D = \text{new capital stock}$
- 

## total factor productivity (TFP)

- portion of economic output that can't be explained by amount of inputs used in production
  - e.g. solar panel installation can be the same but as solar panels get better at harvesting energy we see increased output
- pushing the limits of cutting-edge growth
  - growth due to innovation is much slower typically
- so now we add an  $A$  term

$$Y \propto eLKA$$

- term “lifts” the Y curve, which in turn lifts the I curve, moving the D-I intersection point down the capital axis, moving the cutting-edge growth section of the graph

## the chaebols from south korea’s tech boom

- hyundai, samsung, LG
- SK hynix

## fostering the factors of production

- in 60s SK:
  - invested heavily in health and education
  - sought tech know how in lieu of foreign direct investment or technology licensing
  - developed a robust social security systems

## 1970s industrial revolution begins

- developed basic industries to achieve import substitution
- acquired aging tech to develop a new industry
- south korean factories began innovating and developed new manufacturing technologies
- SK began developing a national innovation system
- lots of funding for R&D
- asian financial crisis in late 90s
  - resources were directed to competitive industries
- SK entrepreneurs leverage human and physical capital to produce valuable products
- entrepreneurs create a climate conducive to risk taking and innovation
- SK had an efficient market that rewarded entrepreneurs for taking risks and investing capital
- north korea had a free rising problem under collectivist, resulting in poor productivity
  - famine in the 90s — millions died

## the important of institutions

- bodies that set and enforce rules that govern economy
- property rights
  - land titles and intellectual property rights give entrepreneurs the peace of mind to pursue tech and business investments
- honest government
  - transparent and accountable government that doesn’t interfere with business development

- relations iwth people, board of trade
- fair legal system
  - dependable legal mechanisms
- political stability
  - civil strife and govt turnover dissuades people from undertaking new business ventures
- open markets
  - markets provide price signals to enable people to adjust and allocate their resources efficiently to where they are needed

## effective institutions

- inclusive institutions
  - encourage investment
  - harness power of the market
  - generate broad-based participation
    - sow the seeds for creative destruction
- extractive institutions
  - concentrate power
  - favour the rich and powerful



WHY NATIONS FAIL THE ORIGINS OF POWER, PROSPERITY, AND POVERTY [indigo link](#)

## corollary to the solow model

- conditional convergence
  - solow model predicts that poorer countries will grow faster than richer countries ONLY if they have equally good institutions
- *is unchecked capitalism the only way? — NO*
- today the pace of tech is the fastest it's ever been
  - but a decline in the values and institutions that foster prosperity has been resulting in a widening of inequality

## evolution of tech-driven development

- during the industrial revolution transformative tech was manufactured and adopted
- combined with strong labour organization and a governmental determination to benefit everyone
- the result was "mass flourishing"

- today the pace is the fastest its ever been

## **institutional failures to regulate technology**

- union carbide disaster in bhopal india
  - india was keen on attracting foreign investment in agriculture
  - happened in 1985
  - judicial system failed, only 1B in reparations mandated
- EPA and dupont case — PFAS are toxic, fought a lawyer for many many years

## **poor shoulder the cost of our prosperity**

- electronics like calcs and computers have benefitted us immensely and end up as harmful e-waste in LICs
- fertilizers and industrial agriculture that enabled the green revolution today cause soil erosion, coastal dead zones from eutrophication, and ruined soil biomes
- atomic bomb tests were routinely conducted in poor indigenous territories in US and smaller islands

## **the way forward**

- engineers need to advocate for inclusive institutions that foster human talents need to develop in order to amplify our institutions' intent to eradicate poverty and reduce inequality
- realize that tech is nothing else but what we make of it

# Week 6 (Feb 8 — 12)

## readings

### innovation within reach (nyt, 2014)

- core idea — innovation doesn't mainly come from flashy breakthroughs or elite labs, often comes from making existing ideas cheaper, simpler, and more accessible to people who are traditionally excluded
- key points —
  - challenges the myth that innovation is high-tech and cutting edge invention
  - highlights frugal innovation: redesigning products and systems to work under tight constraints (low cost, limited infra)
  - constraints are framed as drivers of creativity, not barriers
  - examples show how solutions developed for low-income or resource-poor contexts often end up benefiting everyone
  - emphasizes scaling access, not just novelty
  - argues that innovation should be judged by who it reaches, not who invents it
- takeaway — innovation is most powerful when it focusses on practical usefulness and inclusivity, rather than prestige or technological complexity

### frugal innovation: a narrative review (2018)

- core idea — frugal innovation is a distinct and important innovation paradigm, but its often romanticized and needs more critical analysis
  - especially around power, ethics, and long-term impact
- key points —
  - defines frugal innovation as
    - low-cost
    - resource-efficient
    - designed for how underserved or low-income populations
  - reviews how the concept has been used across academic and policy literature
  - identifies three dominant narratives:
    - frugal innovation as a business strategy (new markets, cost reduction)
    - as a development tool (poverty alleviation, inclusion)
    - as a grassroots practice (local, bottom-up problem solving)

- critiques overly optimistic views that assume frugal innovation is automatically:
  - ethical
  - empowering
  - sustainable
- warns that some frugal innovations:
  - shift responsibility from governments to individuals
  - normalize lower-quality solutions for poorer populations
- calls for more attention to social justice, power dynamics, and who benefits

## midterm

- material — weeks 1 through 6
- duration will be 1 hr 15 mins
- format:
  - 70% concept-checking questions
    - e.g. “give two examples of poverty traps we discussed in class and explain how one can ascertain whether those traps exist
    - 50-50 between lectures and readings
  - 30% 1-2 case studies with short-answer questions

## monday lecture — limits of technocratic interventions

- we think of tech as a vacuum — cant ignore the other aspects of global development, tech is not the only solution to all of the world’s ills
- what is the digital divide and why is it bad?
  - lack of perception,
  - lack of opportunity
  - helps diffusion of ideas and innovation
  - stigmatizes societies

### “silicon valley to the rescue!” /s

- google, microsoft, facebook all tried to help bring internet to the poor masses
- lots of challenges, most initiatives came crashing down



tech may bridge the divide, but that is not enough to alleviate the poverty, internet alone cannot bring prosperity to people

## the case of One Laptop per Child (OLPC) in India

- education has a tremendous affect on one's life earnings
  - why increase in each year for women much greater?
    - women tend to work jobs that require education than men
    - early marriages, early childbearing
    - requirements of creditation, certification
  - increased education (for women) is associated with:
    - 40% improvements to child survival past 5
    - 43% drop in malnutrition
    - reduced fertility rate
- BUT
  - 25% teacher absenteeism — cost the economy \$1.5B annually
  - 23% of schools have no usable toilets
  - WHAT S SHAPED CURVE IS HE TALKING ABT
    - they dont value education at all
    - they view education as a lottery ticket rather than an investment

## how the tech world responds ICT4D

- augmented reality headsets
- video-conferencing lectures
- e-learning centres
- that's not what happened! — at the beginning at least they tried to work
  - inexpensive clickers for student participation
  - gamified education
  - computers that allow numerous concurrent users

## enter the one laptop per child

- unveiled in 2005 at the WEF in davos by nicholas negro ponte
- \$100 PC, estimated up to 150 million laptops could be shipped by end of 2007
- generated \$20M in startup investments as well as sponsor/partnerships
- with major IT industry players, and interest from developing countries
- OLPC did not improve education outcomes — it missed every target it set for itself!
- things laptops can't do

- education is primarily about nurturing students and building their self-confidence
- critical reasoning and articulating cogent arguments is something tech cannot bolster on its own students
- tech is not a substitute for human talent and development
  - all the other techno-centric silver bullets
    - hole in the wall PC in india
      - winner of \$1M TED prize in 2013
      - usage dominated by upper-caste boys
      - internet was intermittent
      - abandoned in 2016
    - LA \$1.3B ipad fiasco
      - teachers weren't trained or had to prepare backups
      - children were too easily distracted especially in LA's poor schools
  - if teachers/students aren't showing up, laptops can't improve educational attainment
  - tech and social inclusion: rethinking the digital divide
  - schools with no IT budgets can't maintain laptops especially in India's hot climate
  - a landmark study found that students that benefitted from Tech4ed innovations were typically already doing well

## law of amplification

- tech can only amplify existing human talent and capacity
  - it can never be an effective substitute for the lack of it
  - the waiter and the new POS analogy
  - problem is hype culture and "linkedinification"
- without nurturing human talent, tech amplifies inequality
  - tech amplifies preexisting differences in wealth and achievement
  - children with greater vocab take away more from wikipedia
  - students with behavioural challenges are more distracted by video games
- low-cost access to technology doesn't necessarily "democratize"
  - democracy is one person one vote
  - with tech it becomes one dollar one vote

## e.g. ai and gender bias

- how AI can help close gender pay gap and eliminate bias

- amazon scraps secret AI recruiting tool that showed bias against women

### **e.g. premise app**

- gig-work app — tapped unwilling users abroad to gather open-source intelligence

## **why OLPC failed to deliver on its targets**

- OLPC is a packaged solution
  - any tech, policy, or easily replicable solution meant to address a social problem
  - often seen as a silver bullet
- other examples:
  - microcredit
  - ID registration programs
  - \$1 educational microscope
- packaged solutions almost always overpromise but underdeveloped
- for OLPC:
  - \$100 was too ambitious
  - crank-powered mechanism was too flimsy
  - real world operating conditions were too harsh leading to laptop failures
- attempts to pivot also fail
  - when the XO failed, negroponte promised to drop tablet versions from helicopters in remote helicopters
- packaged solutions often forget all non tech problems
- implementers and beneficiaries lack the holy trinity of human virtues necessary for success
  - mind (discernment)
  - heart (intention)
  - will (self-control)

## **the major distortions of the technocratic age**

1. measurement over meaning
  - a. value only that which can be counted
2. quantity over quality
  - a. do only those things that impact millions of people
3. ultimate goals over root causes
  - a. focus narrowly on the end goal to ensure success

4. destinationism over path dependency
  - a. failing to adjust course when the circumstances demand it
5. rely on external change over internal change
  - a. do not expect people to change; instead focus exclusively on their external circumstances
6. innovation over tried-and-true solutions
  - a. never do anything that has been done before, at least not without new branding
7. individualism over collectivism
  - a. let competition lead to efficiency, avoid cooperation, which breeds complacency and corruption. freedom over responsibility

## **institutions that got it right: seva mandir**

- problem: 25% teacher absenteeism in india
- innovation
  - MIT researchers provide teachers with tamper-proof cameras
  - student must take a picture of the teacher in class every day
  - teachers rewarded 50 extra each day they taught
- impact:
  - increase in attendance by 21%
  - 34 more days of instruction per student per year
  - higher student test scores

## **tech that get it right: digital green**

- the innovation:
  - organizes rural communities to share knowledge on improved agricultural practices and livelihoods through locally produced videos
  - human-mediated dissemination
  - grassroots, participatory model that amplifies the efforts of existing solutions
- impact:
  - increased adoption of agricultural tech by 7x
  - 10x more cost effective than traditional extension efforts
- why it worked:
  - thrill of appearing on TV
  - exploited "homophily" to minimize the distance between teacher and learner



find the people who are doing well, help them do better, then try to spread their ideas/knowledge downwards

## is democracy a packaged intervention?

- idea is that democracy works for us here — if we simply export it, it should work just as well
- reductiveness of the western media's interpretation of what was happening
  - perspective was reductive to the actual people at the lowest level calling for change

## techno-utopian headlines?

### however

- less than 25% of tunisians had internet access in 2011
- civil unrest was present for decades in arab countries
- civil society and NGOs mobilized in the background long before facebook existed
- facebook merely helped them organize efficiently
- social media amplified people's underlying intent and desire to overthrow the status quo

## techno-democratization?

- utopian idea that the internet like social media leads to democracy
  - seeds of democratic revolution must exist in society first
  - people struggling to survive cannot grasp the concept of majority rule
- democracy unpackageable. it requires:
  - rule of law
  - robust free press
  - widespread education
  - strong governing institutions
  - transparency
- if revolution wasn't going to happen without social media, it will not happen because of its presence
- governments have since recognized the importance of social media
- today they use to crack down on dissidents
- where the social media platforms dont cooperate, they band them or limit access

## drones as a double-edged sword

- good: delivering blood bags to remote health centres in Rwanda — zipline
  - Rwanda had the right mix of entrepreneurial spirit, need for this idea, regulatory hurdles that allowed for
- bad: bombing civilians with home-made low-cost drones in Libya and Iraq

## **week 09 — challenges of conducting and scaling up global engineering research (aquaculture research)**

### **where it started**

- grant agency — grant challenges Canada
- award was \$100,000
- funding duration was 2 years
- focussed on utilizing tech innovation to boost yields for pond aquaculture
- wanted to see results within end of year 2

### **motivation: importance of aquaculture**

- over 1B obtain most of their protein from fish
- a wild fish capture declines, aquaculture is becoming more vital
- 90% of aquaculture takes place in APAC employing over 20M people
- more families in the region are becoming reliant on AQC for food security and income
- however, yields in small scale are very poor

### **lack of aeration systems in rural pond aqc**

- pond aeration is a vital element of water quality management in aqc
- traditionally done using energy and capital intensive aeration systems
- +64% for stocking density and +47% for gross yield
- most dissolved oxygen at the top, need to circulate it around
  - [least at bottom]

### **proposed concept: convective solar-themed circulation**

- key benefits: no electricity required, inexpensive, minimal maintenance, easily deployable

### **research timeline**

- step 1
  - characterize dissolved oxygen dynamics

- temp model, dissolved oxygen dynaocs
- step 2
  - size device and predict impact
- step 3
  - field trials in vietnam and bangladesh

### test site: vietnam

- sensors worth \$7k sat in a dingy fedex office
- measured parameters
  - solar irradiance
  - ambient temp
  - wind speed
  -



randomized control testing (RCT) is the gold standard for testing whether a new technology works or not

## where did everything go wrong?

### (1) good partners are rare

- there was a uni in Bangladesh would said he'd help, needed them to collect water samples and measure cholo???? in the water
  - he had undergrads working on it and it was all wrong
- hat to look for: the holy trinity
  - mind (discernment)
  - heart (intention)
  - will (self-control)
- things we overlooked
  - proper training manuals and protocols
    - especially with data collection
  - incentives for field staff
  - instilling motivation and ownership of the project among field staff
    - trust underpins any technological intervention
  - clear timelines, team charter, risk registers, configuration management

## **(2) the shadow of silicon valley**

- let's look at some silicon valley gems
  - wework
  - ftx
  - theranos
  - nikola
  - frank
  - ozy
- dont rush things! take your time and test and follow all steps of the design process

## **(3) unreasonable donor expectations**

- research in global development is typically funded through
  - granting agencies
    - bill and melinda gates foundation, acument fund
    - funding often in range of 50k to 2M
    - expect results in 2-5 years
    - are willing to fund early-stage tech research
  - debt investors
    - private or public
    - funding often in the range of 200k to 10M
    - expect healthy balance sheets and predictable cash flows
  - equity investors
    - typically private sector
    - funding often in the range of 1M to 10M
    - expect rapid growth and a well-defined business plan
  - blended finance
- BUT research is slow
- stakeholder timelines dont always line up
  - grand challenges canada — 2 years
  - masc — 2 years
  - PhD — 4-5 years
  - professor tenure track — 5 years
- many donors expect early prototypes and field trials

- pilot-itis: observation that technologies always succeed in pilot experiments but fail during scale-up
  - why do you think that happens?

#### (4) rossi's metallic laws

- iron law of evaluation
  - expected value of any et impact assessment of any large scale social program is zero
- stainless-steel law of evaluation
  - the better designed the impact assessment of a social program, the more likely is the resulting estimate of net impact to be zero
- brass law of evaluation
  - the more social programs are designed to change individuals, the more likely the net impact of the program will be zero
- zinc law of evaluation
  - only those programs that are likely to fail are evaluated
- the chef or the ingredient
  - scaling up is crucial but very hard to get rihgt
  - voltage drop effect
    - insufficient heart, mind, and will in participants and implementers
    - risk of false positives
      - never stop experimenting
      - replicate before you scale
    - focus on community sensitization and finding champions
  - talent doesn't scale, learn from others
  - fall in love with the problem, not the solution
  - sometimes, it's just not worth it



almost nobody will care about the project more than you, there will always be a distance between you and them