

# Challenges and Opportunities in the Engineering Profession

## The Unnat Maharashtra Abhiyan

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[www.ctara.iitb.ac.in](http://www.ctara.iitb.ac.in)

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# Organization of the talk

- What is Engineering
- Engineering in India and key problems
- The government viewpoint
- The Unnat Maharashtra Abhiyan
- A new university and its curricula and research

## *Students:* Why are you here?

- My parents sent me here.
- I have always wanted to be an engineer.
- I liked Physics and Maths in School.
- I want a good job.
- I want to do something for society.
- I like making things.

### Two Questions!

- What is science and what is engineering?
- What are the prospects for engineering in India?

# What is engineering?

and how do we measure it?

- Number of scientific instruments in schools.
- Number of buses per 1000 people.
- Number of liters of water per person per day?
- Number of factories. Number of manufacturing jobs.
- Length of roads per 1000 people.
- Units of electricity per person per year.

*material well-being of society*-sustainable, equitable and efficient

# Sectors and employment

## Sector-wise GDP

India	Agriculture	Industry	Services	Per capita ( in USD)
GDP (2012) (%)	17.4	25.8	56.9	4K
Employment (%)	51.1	22.4	26.6	-
GDP China	10	44	46	9K
GDP S. Korea	3	40	57	30K
GDP Germany	1	28	71	43K

## Top Formal Employers

Industry	Food	Textiles	Metals	Apparel	Non-metals
Wages (Rs. lakhs)	0.70	0.80	1.35	0.67	0.69

# Jobs

## Engineering Placements 2013 (IIT Bombay)

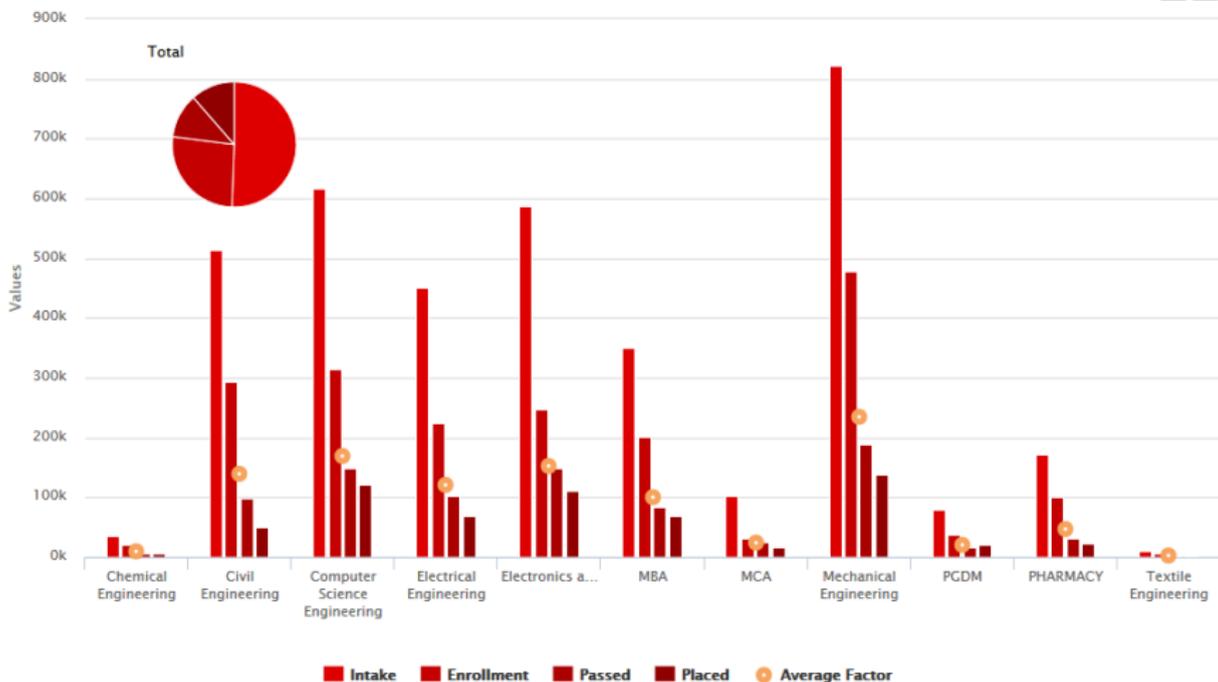
Sector	Engg.	Finance	Consulting	IT
Super-GG	25 (27.7)	10 (35.0)	8 (49.6)	41 (52.1)
GG	116 (7.9)	82 (11.7)	110 (9.6)	102 (10.0)
IG	52 (6.5)	19 (7.2)	11 (5.8)	28 (7.2)
GI	24 (9.3)	10 (14.2)	10 (5.2)	5 (9.3)
II	64 (6.5)	13 (9.5)	8 (5.8)	22 (7.9)

Table : Numbers by sector and profile and average annual salary in Rs. lakhs

**So, why are IIT graduates not doing engineering?**

# Placements in Engg.

Engineering/MBA/MCA/Pharmacy–Course vs Intake/Enrollment/Passed/Placement for the academic year: 2015–2016



# Effects!

Steel consumption.

India	57	China	477
Other Asia	69	Japan	506
Egypt	95	USA	306
UK	145	Netherlands	200

Year-round drinking water availability.

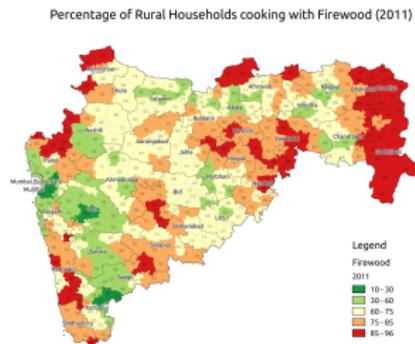
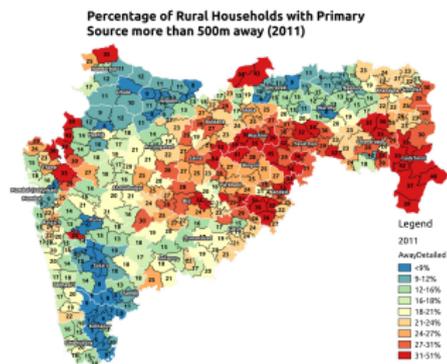
Year	Rural	Urban
2012 (69th NSSO), per 1000	858	896
Maharashtra	<b>745</b>	931
2008	862	911

Find out about Milk, Electricity, Cooking Fuel.

And this is how we are ...



# And this is how we are ...



Data from Census 2011

# Conclusion

- Very slow progress in meeting development needs.
- Poorly functioning industry sector. Poor productivity, inability to attract best talent.
- **Increasing need in key areas and unmet demand!**
- **How can engineers deliver better value?**

## 4 Questions

- Why is this mis-allocation happening?
- Where and and which sectors are the jobs going to be?
- How are these jobs going to be created?
- How do I prepare for these jobs?

# Some Answers

Electrical engineering-

	AICTE	UNIV OF ILL	NUS	IIT-D	COEP*
Basic Engg and Sci	60 (34.1%)	34 (31+3) (26.56%)	34 (21.25%)	55 (36.67%)	50 (28.25%)
Humanities and SS	14 (7.95%)	18 (14%)	20 (12.5%)	15 (10%)	9 (5.1%)
Core	50 (28.41%)	28 (21.88%)	40 (25%)	60 (40%)	73 (41.24%)
Core Electives	20 (11.36%)	32 (25%)	22 (13.75%)	10 (6.67%)	15 (8.47%)
Open Electives	12 (6.82%)	12 (9.38%)	16 (10%)	10 (6.67%)	15 (8.47%)
Others	Project and Internship-20 (11.36%)	Principles of Composition (Writing)-4 (3.13%)	Project and Industry-28 (17.5%)		Project-14 (7.9%)
Total	176	128 + 20 (minor)	160	150	177

- Focus on big-company engineering. More theory, less practice.
- Less freedom, over-qualified. **No comprehension of value.**
- **More loyal than the king.**
- **Output:** Service sector!

# Research Papers

**Table 3.** Number of papers with phrase in the title and with at least one author from India (Scopus)

Topic (phrase)	All years preceding 2003	2003–09 (TEQIP I)	2010 onwards (TEQIP II)
Neural network	692	1818	2467
Fuzzy logic	110	327	759
Wavelets	96	905	1846
Genetic algorithms	262	989	1373

**Table 4.** Number of papers with phrase in the title and with at least one author from India (Scopus)

Topic (phrase)	All years preceding 2003	2003–09 (TEQIP I)	2010 onwards (TEQIP II)
Water supply	84	74	87
Sanitation	30	51	63
Groundwater models	11	29	70
Public transport	5	15	25
Power grid	12	56	288

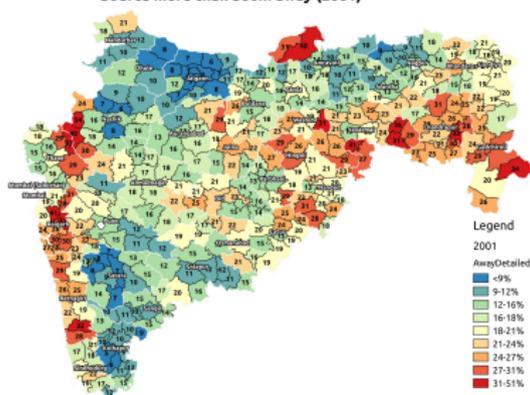
# How does GoM or Gol see it

- **Where will jobs come from?**
- **How will we fix basic services?**
- **Who will strengthen small enterprises?**

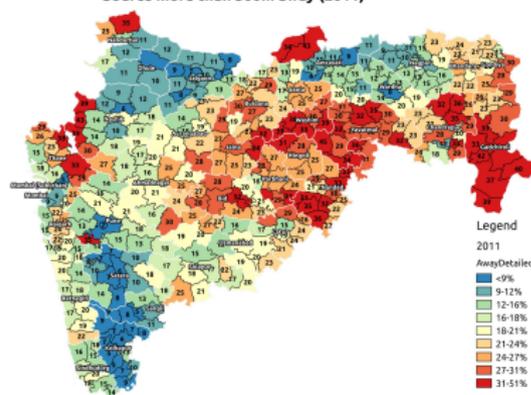


# The development challenge

Percentage of Rural Households with Primary Source more than 500m away (2001)



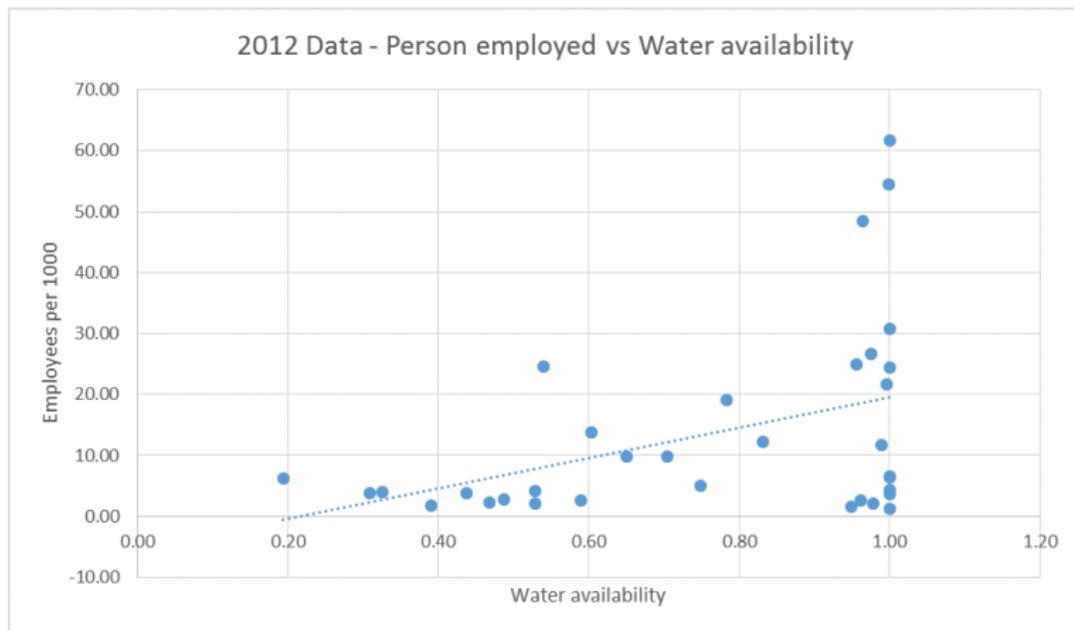
Percentage of Rural Households with Primary Source more than 500m away (2011)



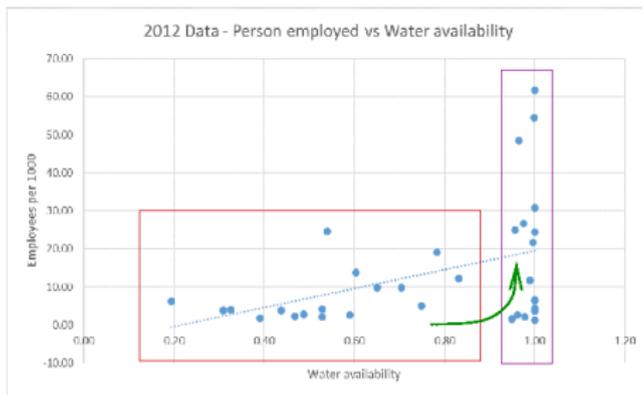
## Other Metrics as well

- Year-round access to DW-74%.
- droughts, chulhas, public transport, small manufacturing etc.
- **missing** : institutions, community and private sector-*knowledge*

# Urban water Availability and Jobs



# District-wise Urban water Availability and Jobs



Better Amenities  $\Rightarrow$  More jobs

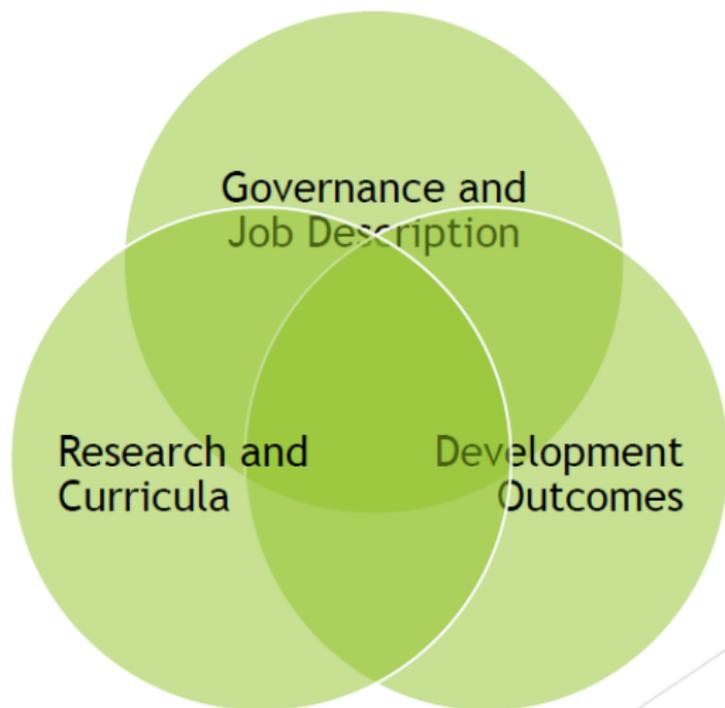
New Knowledge, New Professions  $\Rightarrow$  Better Amenities

**Conclusion:** New jobs will begin in the development sectors!

New and hard applied research. Student and faculty Interest.

**New Mechanisms. Understanding how is value created!**

# What does GoM want



# Unnat Maharashtra Abhiyan

Started by Govt. of Maharashtra in January 2016.

## Objectives:

- align higher education with demands of regional development
- create avenues for students, faculty members and institutions for participation
- through curricula and research, create new professions and new professionals of the future

# The basic argument

Better Outcomes

Water, Public Transport, SME, Energy



Need for Knowledge, New Practices, New Research  
New Job Profiles, Avenues for Professionals.



The role of University and Higher Education  
Knowledge Structures. Key Areas.



Mechanisms for a Partnership

# Can Universities help?

A unique and welcome GR(15/6/2015) from Water Supply Dept.

- Every new PWS must undergo 3rd-party assessments.
- Every CEO-ZP to identify college to perform these assessment. 1% of capital costs to be paid.
- Selected college must form an inter-disciplinary cell, prepare success criteria, advise on good practices!

District	Palghar	Thane
Number of schemes	19	12
Sanctioned amount	Rs. 28.2 Cr.	Rs. 6.4 Cr.
Major Issues (Design)	7/19	9/12

## Learnings

- Bad practices and issues identified. **New research generated.**
- **Rs. 34 lakhs to colleges** but...**Positive returns already for GoM.**

# The Unnat Maharashtra Abhiyan (13/01/2016)

## Objectives

- Align teaching and research in engineering with state's development agenda. **Understand value and outcomes.**
- Mechanism for **select** regional colleges to access funds and data.
- Support the *Right To Know* for communities.

## Features

- **Project Areas.** Water, Sanitation, Electricity and Energy, Public transport, rural and household enterprises.
- **Programs.** e.g., Jalyukta Shivar, Thakkar Bappa.
- **At the college.** Technology and Development Cell.
- **Nodal Agency.** District Collector, DPC and District Innovation and departmental M&E funds.
- **Mentored by CTARA at IIT Bombay**

# More GRs

- **Planning, 7th April, 2016.** Source of funds.
- **HTE, 15th June, 2016.** Topics and guidelines.
- **planning, 20th July 2016.** Images from MRSAC for govt. projects.
- **Planning, 22nd July 2016.** IIT Bombay as 3rd party *overall* evaluation of programs and projects.

## The Future

- **Planning.** DPO as nodal office for UMA. Periodic clarity on funds.
- **GAD/Planning.** Support for UMA in 3rd party assessments.
- **UMA as a network of trusted institutions**

## Needed

Reform. Field-work, social context, inter-disciplinary, curriculum and R&D reform. **Trust.**

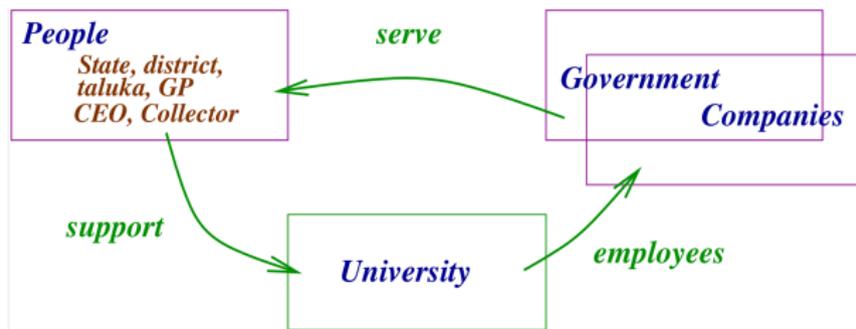
# UMA Areas

<b>Broad Area</b>	<b>Type of service</b>	<b>Case study</b>	<b>Fees</b>	<b>Possible Core Departments</b>
<b>Rural Electricity</b>	QoS analysis	Rural electricity stress assessment for a feeder/village cluster	4-8 man months	EE, CSE
	Assessment and analysis	Socio-economic and technical analysis of agricultural feeders	4-8 man months	EE
	Agriculture pumping	Techno-economic feasibility of implementing energy efficiency and renewable energy /hybrid solution	4-8 man months	All
	Rural household	Techno-economic feasibility of implementing energy efficiency and renewable energy /hybrid solution	4-8 man months	All
	Assessment and analysis	Socio-economic and technical analysis of domestic and informal sector use	4-8 man months	EE, Mechanical, Chemical, etc. (depending on industry)
	Feasibility study, assessment and design	Network components and design for reliability and QoS	1-2% of project cost	EE, Mechanical

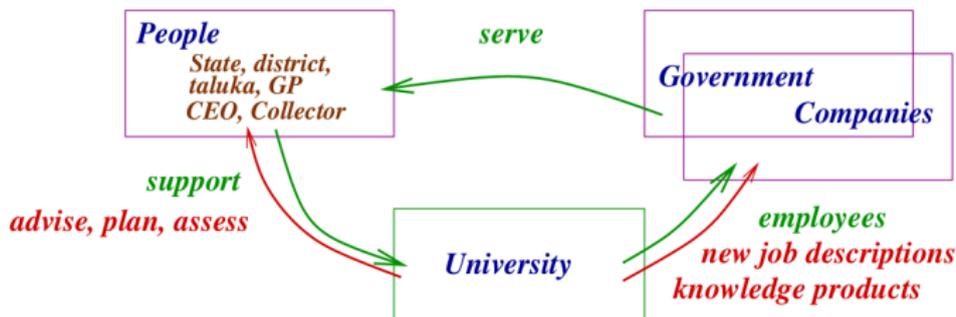
# UMA Areas

<b>Resources</b>	Logistics and planning	Groundwater utilization and regulation for a specific situation	4-8 man months	Civil, Mechanical, Chemical
	Feasibility assessment and design	Assessment and design of watershed programs such as JYS or IWMP	1-1.5% of plan cost	Civil, Env. Sci. and Engg.
<b>Irrigation</b>	Feasibility assessment and design	Assessment of regional and sub-taluka minor irrigation systems	4-12 man months	Civil, Env. Sci. and Engg., Agriculture
	Feasibility assessment and design	Water use efficiency of irrigation systems	4-12 man months	All
	Feasibility assessment and design	Assessment and improvement of distribution systems	4-12 man months	Civil, Env. Sci. and Engg., Agriculture
	Third party audit	Water use and socio-economic analysis	4-12 man months	All
<b>Rural industries</b>	Feasibility study and assessment	Standardisation of processes for specific rural industries	4-12 man months	All
	Logistics and planning	Technological and business support to regional industrial clusters	4-12 man months	All
	Feasibility study and assessment	Use of cold storage supply chains for food processing	4-12 man months	All
	Research and Design	Improvements in productivity of poultry industry	4-12 man months	All

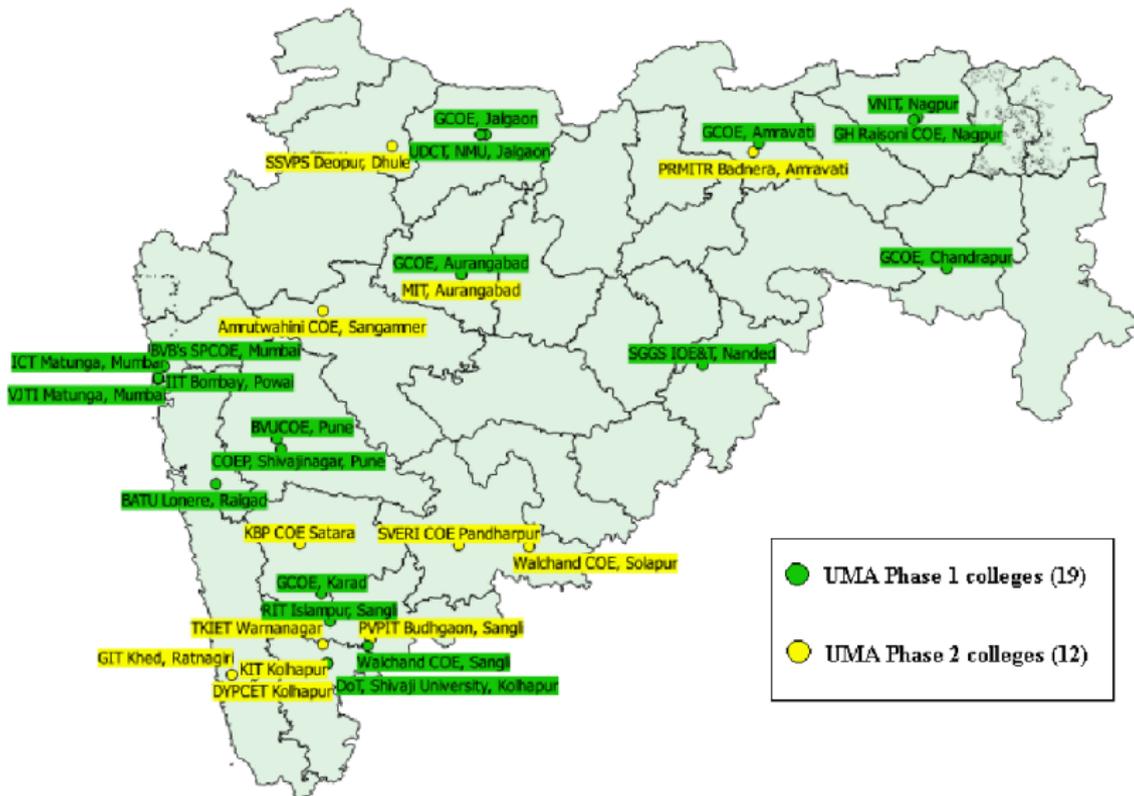
# The Big Picture - What used to be



What we now need...



# UMA Institutions



● UMA Phase 1 colleges (19)  
● UMA Phase 2 colleges (12)

# UMA work in pictures



Plastic road (KBP Satara)    Cleaning of Krishna River (BVP Pune)    Irrigation at Sinnar (CTARA, IIT-B)



Solar Dryers (SSVPS Dhule)



Pencil Inspection & Sorting

Camlin Pencil Sorter (PVPIT Budhgaon)

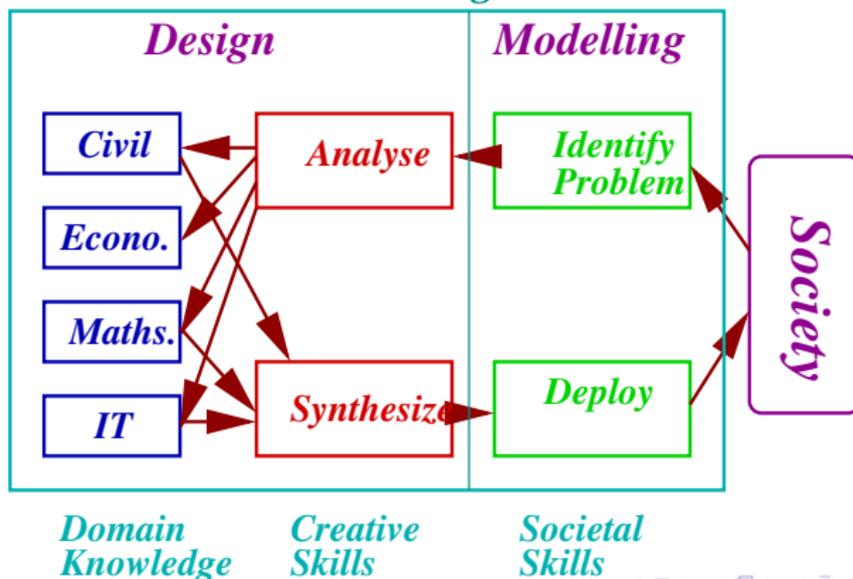
# UMA Colleges at work



# The New Engineer

- Identify a *societal problem* and a *stakeholder!*
- Analyse the problem and separate it elementary subproblems
- Solve, Synthesize and Deploy the complete solution.
- The true engineer is *inter-disciplinary*

## The True Engineer



# The Regional Engineering Framework

Department	Last-mile areas
CSE	Public Transport, PDS logistics
Economics	District Economic Plan, GP development plan
Civil Engg.	Taluka DW plan, Low-cost housing
Elec. Engg.	Household efficiency, Agricultural Feeders
General Engg.	Urban Local Body, Bus Depots, Irrigation Systems
Planning	Electricity, Water, Sanitation, Energy

- **Development Engg.:** an inter-disciplinary course.
- More field-work, more space for electives. Project based learning.
- Interactions with regional agencies. **Systematic interaction with people.**
- **Case-studies. Planning.**

# Composite Skills-Academic Framework

## The Case-study

- Assessing PDS coverage in a Gram Panchayat. Evaluating *anganwadis*.
- Preparing the Bio-diversity register for a GP. Forest plans.
- Computing the agricultural GDP in a taluka. Recording farmer narratives.
- Preparing a village sanitation and waste disposal plan.
- Preparing ideal time-tables for city public transport system.
- Guiding municipal corporations in energy efficiency.
- Visiting a Poha Factory. Designing a *haldi* cooking machine.

## Exciting -Comprehension and Delivery

- All areas of knowledge.
- Soft-skills, data, maps and quantification, analysis, scientific temper, reporting, documentation.

# The concrete cycle-I

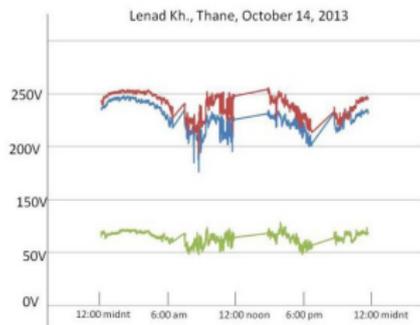
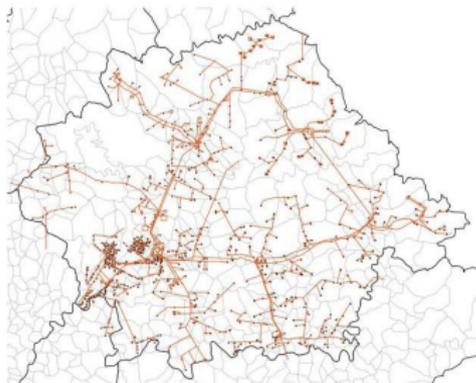
- Energy bill reduction through the use of solar dish.
- Conversion of *Istry* from electricity to steam.
- How to make leaf-plate making more efficient.
- Supply chains for bio-mass power plants.
- Temperature regulation in poultry farm.



# The concrete cycle-I



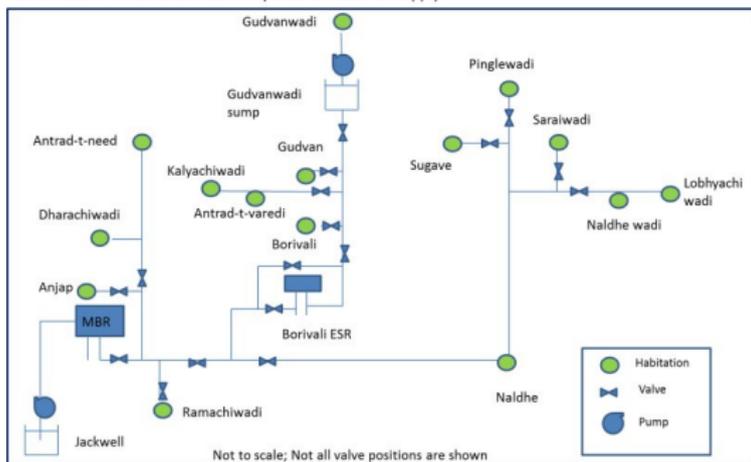
# The concrete cycle-I



- Power quality meter-3-phase, voltage, power factor, harmonics
- Measurements at irrigation pumps
- Mapping of *taluka* grid.

# Sample Projects

Schematic of infrastructure currently used for seasonal supply



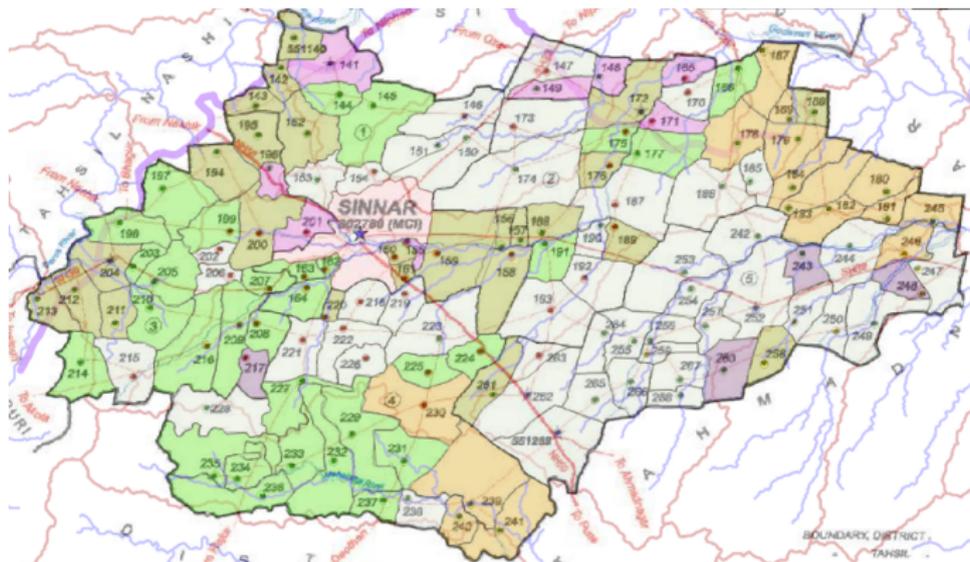
Analysis of a failed rural regional(RR) Water supply scheme. Designs for many other.

# Sample Projects



Rooftop solar plan for a complete gram-panchayat (Kerala).

# Sample Projects



Irrigation plans for your district or taluka.

# Is there policy space? Plenty

## Objectives of University [4.6]

*extend the benefits of knowledge and skills for development of individuals and society by associating the university closely with local, regional and national problems of development*

## Powers and duties of university, inter alia, [Sec 5.17]

*to make provision, wherever feasible, in the university departments, colleges, institutions, recognized institutions and schools, for survey and collection of statistics, data and other particulars relevant to various developmental activities including State and National plans, evaluation of the developmental schemes with the participation of the students as a part of their curricular activities”*

## Powers and duties of university, [5.74]

*to identify skills to which students need to be exposed to, by taking into account the local needs, training facilities available, emerging needs and new employment opportunities*

## Powers and duties of the Board of Research[Sec 60 (I)]

*to identify problems and issues related to the region within the jurisdiction of the university and to take special initiative to address such issues through systematic research*

## The functions and duties of the Commission[Sec. 77.1]

*(m) to prepare programmes in the various subjects in the sphere of higher education, keeping in view the overall priorities, perspectives and needs of the society and expectations from higher education*

*(zf) to review the approach and methods adopted by the colleges and universities, both public and private, for integrating education with social development and to study the impact of such an approach on social development and suggest ways and means to make it more efficient and effective*

## [Sec 107] Perspective Plan Coverage and Access

*(5) "The university shall initiate a time bound programme to prepare an annual plan every year for the location of colleges and institutions of higher learning, in consonance with the perspective plan and shall publish it before the end of academic year preceding the year in which the proposals for the opening of new colleges or institutions of higher learning are to be invited."*

*(6) The University shall undertake the systematic field survey within the geographical jurisdiction of the University every five years regarding the requirements of the facilities of Higher Education, types of skills needed for the local industries, trade and commerce, aspirations of youth of the region..... The university shall use the findings of such field survey and develop the scientific database while preparing the perspective plan of the university.*

# Jadhav Committee Recommendations

## University Perspective Plans: **Broad Objectives**

- Importance of R&D, policy, objectives, incentives and measurements.
  - ▶ Its utility in teaching and infrastructure
- The need for composite skills.
  - ▶ Each teacher to develop one. Importance of teacher training.
  - ▶ 2-3 case-studies for every student. Related to course-work.
  - ▶ Building overall competence and delivery of value.
- Address rural-urban divide and social back-wardness
  - ▶ stress on uniformly good quality, access and equity
  - ▶ address basic amenities, jobs and relevance

# Detailed Guidelines

## Curricula and Research

- Prepare manpower for future needs. Enable learning of composite and **inter-disciplinary** skills. Innovative programs.
- **Make research topical and useful.**
  - ▶ Consult regional agencies, DPC, DIC and society in general.
  - ▶ Decide on areas of research, incentives, metrics.
  - ▶ Set up **Regional Research Cell** at university and college level for industry and society to access.
- Evolve partnerships with local industry. Training and Entrepreneurship support. Engage and understand research needs.
- Invest in Teacher Training Cells.
- **Enhance the social role and responsibility of the University.**

# Links and References

## Sites:

- [www.ctara.iitb.ac.in](http://www.ctara.iitb.ac.in): CTARA, a center of IITB devoted to technology and development. Also see TDSL in Academics at CTARA, for a variety of case studies.
- [www.ctara.iitb.ac.in/tdsc](http://www.ctara.iitb.ac.in/tdsc): Our Technology and Development Cell.
- [www.ctara.iitb.ac.in/tdsc/uma](http://www.ctara.iitb.ac.in/tdsc/uma): Documents on Unnat Maharashtra Abhiyan.

## Talks on youtube :

- <https://www.youtube.com/watch?v=G71maumVZ1A>: On the role of engineers in development.
- <https://www.youtube.com/watch?v=Y5KtCEI-x8E>: Science, Society and Culture.
- See <https://www.youtube.com/watch?v=fc5WsQBJqcs> for placements in engineering, esp. IITs.

# Thanks

