Recommendations Towards Development Engineering

Implementing the UBA

Second Meeting of All India Board of Under Graduate Studies in Engineering and Technology

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Today's Agenda

- Demand Side: Status of today's engineering and of development indices
- Supply Side: How are the institutions doing?
- Reasons and how to overcome
- One step: UBA
- Recommendations
- Does it fit overall policy frameworks
- How to implement it

References are provided at the end.

Economy: Sectors and Employment

- Sector Wise GDP (World Bank database)

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 (Labour Bureau, Govt of India)

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

Usual formal vs. Informal- low technology, poor conditions

Other Indices

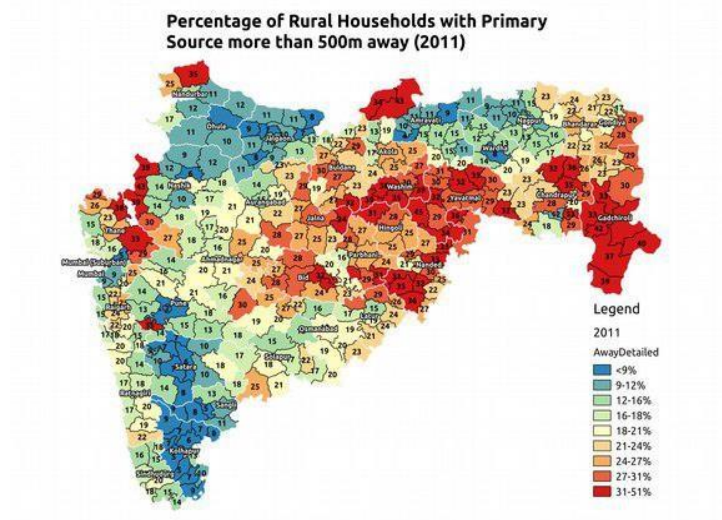
- Steel Consumption (World Steel Association)– points to lack of virtuous cycle in railways, roads, infrastructure

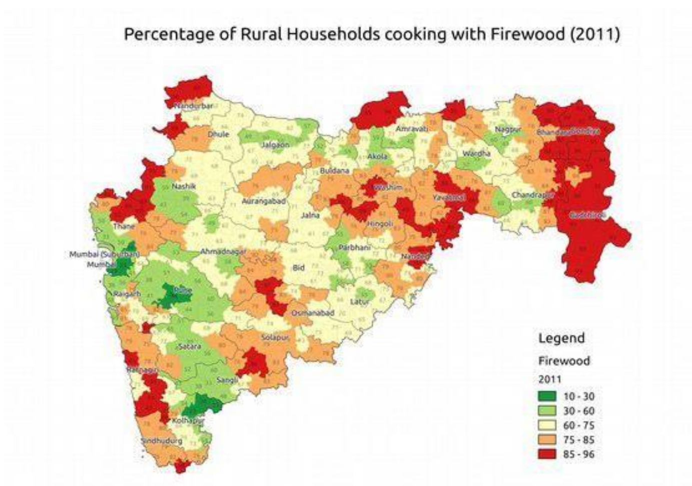
India	57	China	477
Other Asia	69	Japan	506
Egypt	95	USA	306
UK	145	Netherlands	200

- Year Round Drinking Water Availability (NSSO, Census)

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

Severe Stress in Key Areas





Our engineering teaching and research infrastructure

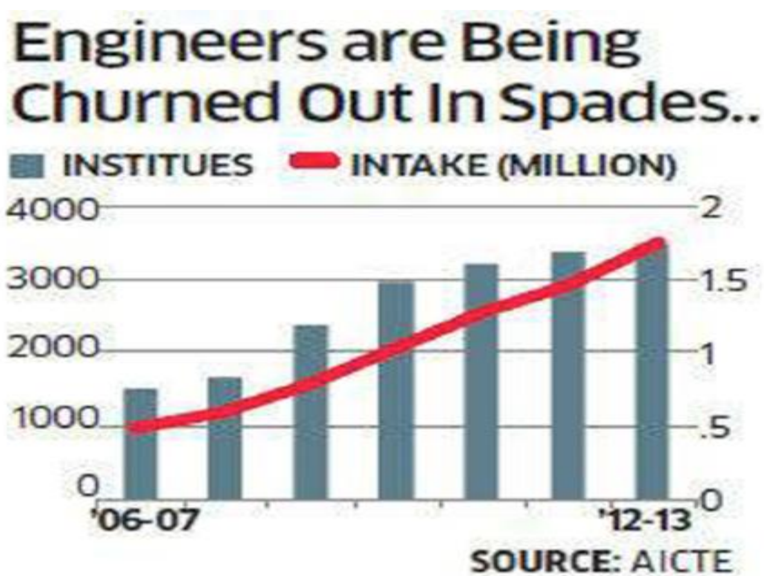
- Teaching-layered institutions-centrally funded, state, private
- Curriculum-Many changes from Thomson College (state engineering) to COEP, Madras to IITs and RECs
- Focus on abstract scientific and less on practical and empirical systems
- JEE GATE as key norms for measuring high school science and engineering education outcomes!
- Research: DST and other GoI agencies. Very little at the state level. Very little at the application level, e.g., MDWS or MORD or MOUD.
- Little accountability of R&D or engineering education to end-user. NO systematic data.

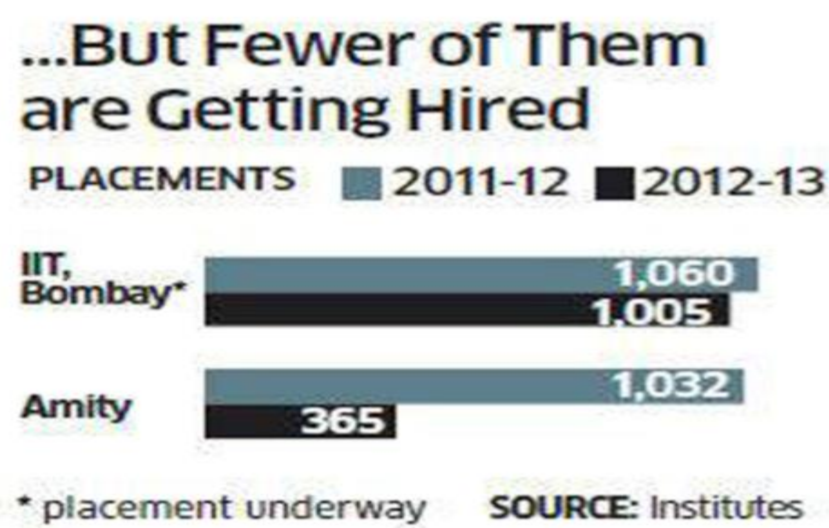
AICTE and its Role

- Maintaining standards– institution and curricula
- Admissions of students and measuring performance of institutions
- Curriculum design for meeting societal needs
- Guidance on the conduct of research and development

Issues in Engineering

- India produces 1.5 million engineering graduates every year, as opposed to 95,000 in the US
- The number of engineering colleges was 3,345 in 2014-15
- Needs of the informal sector are not being met
- IT continues to be the most attractive sector





TEQIP, NBA and NAAC

TEQIP

- Much in governance and administration, little in technical content
- Push for globalization, no regional push
- Centers of excellence, publication in international fora
- Tepid outcomes

NBA/Ranking

- Accreditation based on model curricula
- ABET but without the "Body of Knowledge" handbooks
- Led to stress on GATE

IITs remain at the top and as role models

Role of elite engineering institutions (such as IITs)

The elite and model educational institutions, such as the IITs, are best positioned to lead the way in defining new ways of conducting engineering education. This is enshrined in their objectives as well, such as-

- To provide research and development consultancy which will promote contact with and be of service to industries and to government and Civic Organizations.
- To organize quality improvement programs for faculty members from various engineering colleges.
- To provide leadership in curriculum design and development.
- To organize short intensive courses, conferences and seminars on current technological developments which will be of benefit to the surrounding community.

Placements

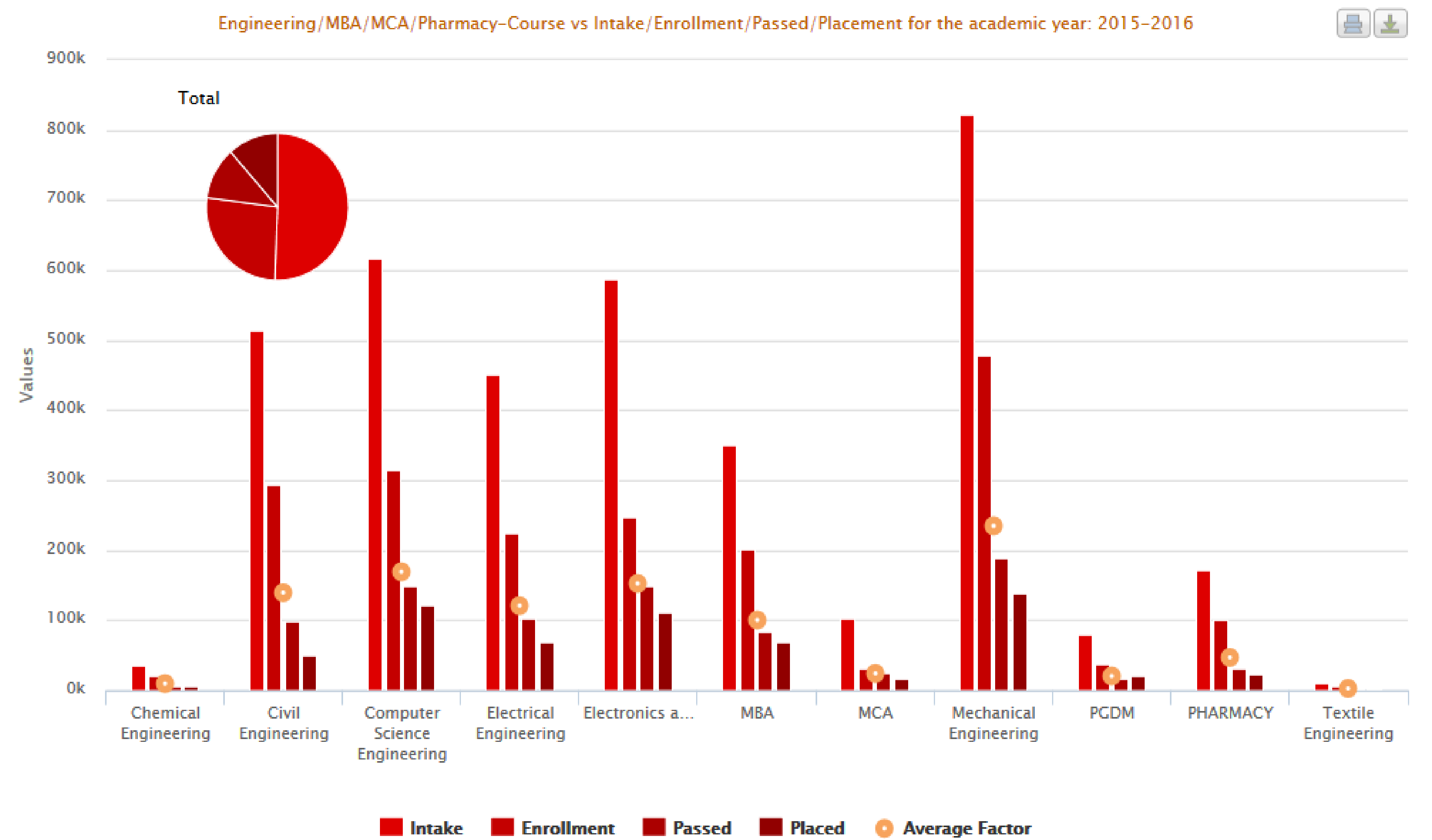
Engineering Placements 2013 (IIT-Bombay)

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

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)

So why are IIT graduates not doing engineering?

Placement (AICTE website)



Research Areas

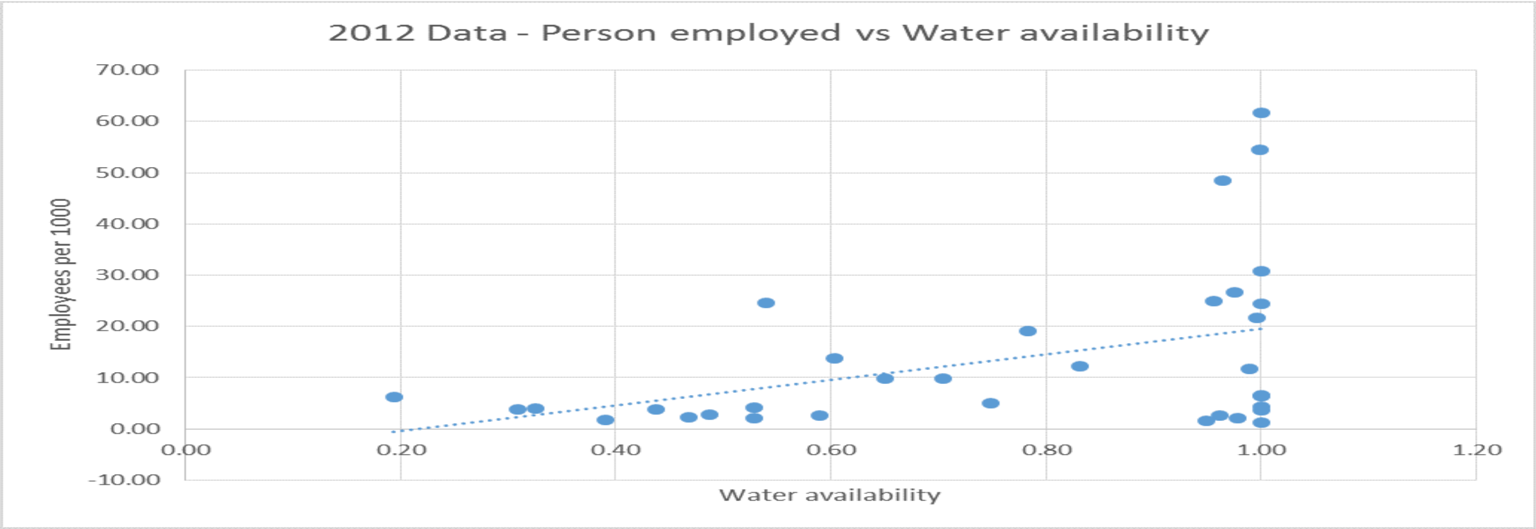
- Misallocation of effort and funds into research in areas which are not relevant

Table 4: Number of papers with phrase in the title, with at least one author from India (Scopus)			
Topic (Phrase)	All years preceding 2003	2003-2009 (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

Table 3: Number of papers with phrase in the title, with at least one author from India (Scopus)			
Topic (Phrase)	All years preceding 2003	2003-2009 (TEQIP I)	2010 onwards (TEQIP II)
Neural Network	692	1818	2467
Fuzzy Logic	110	327	759
Wavelets	96	905	1846
Genetic Algortihms	262	989	1373

Development and Engineering

Provision of an urban amenity such as water is a precursor to industrial growth



The graph shows the relationship between persons employed in the formal sector (per 1000) and availability of water in the districts of Maharashtra (weighted average across all talukas).

Development and Engineering

Development of rural industry leads to industrial growth and higher HDI.

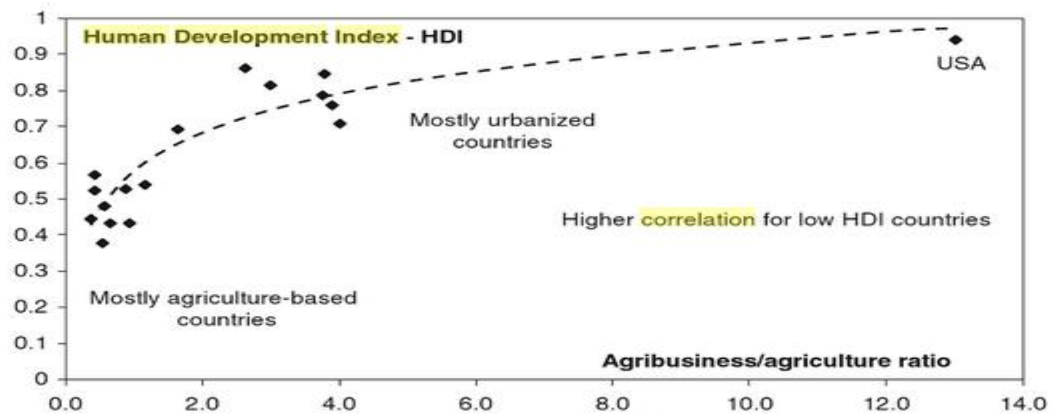


Figure 1. Correlation between human development and the agribusiness/agriculture ratio.

The graph depicts the relationship between HDI and agribusinesses across countries.

Supply of Development Engineering Services

- Clearly, there is a strong *demand* for basic engineering services (sadak, bijli, paani and rural enterprises).
- The supply of such services should come from engineering institutions such as the IITs and other regional engineering colleges.

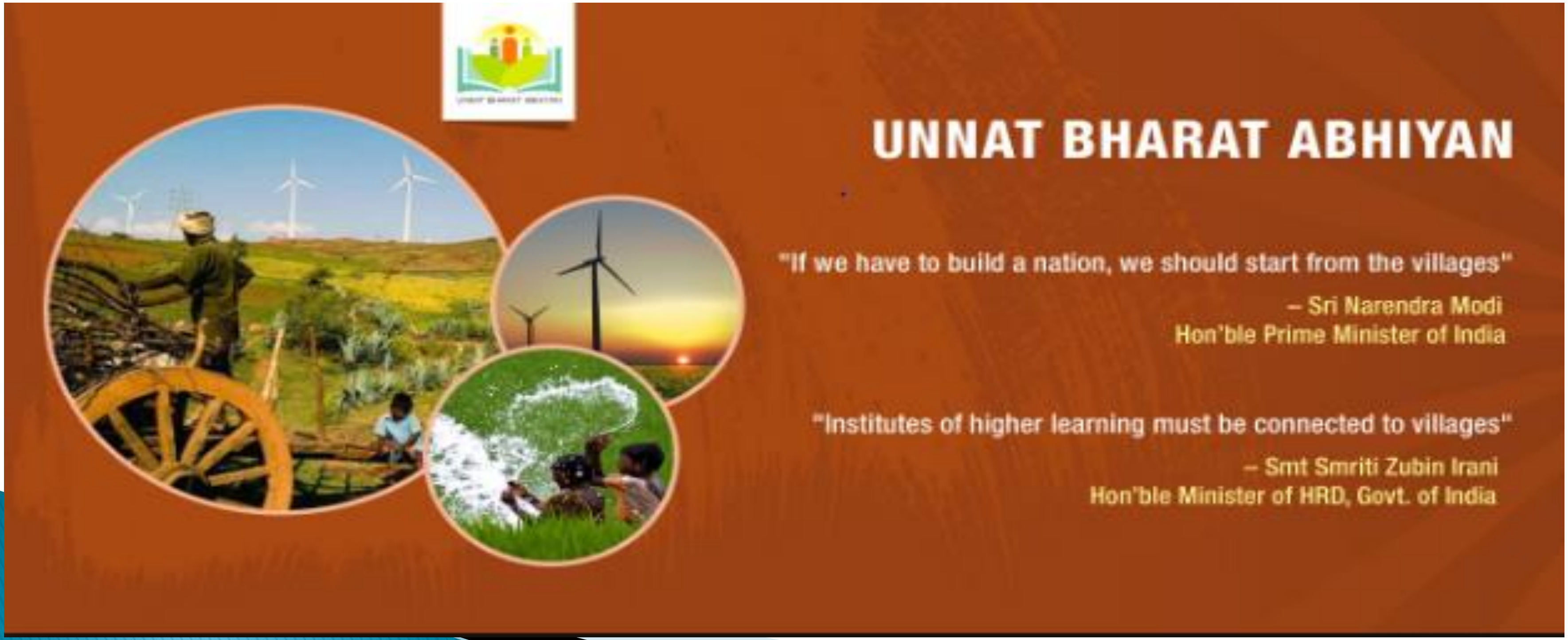
However, there is a demand-supply mismatch. Domestic engineering colleges are not meeting their mandate.

- International social science programs offer inter-disciplinary and eclectic courses in South Asian Studies and Development Studies.
- Multilateral agencies such as World Bank are involved in provision of basic amenities.
- International engineering programs are focusing on inter-disciplinarity, planning, work with industry/state. One interesting example is the MIT Tata Center for Technology + Design.

New journal from Elsevier: Development Engineering!

Unnat Bharat Abhiyan (UBA)

The UBA mechanism offers a solution to the problems and demands of development.



UBA Goals

Broadly speaking, UBA plans to achieve the following-

- Seek an alignment of curricula and research with regional development needs
- Re-emphasize field-work and case-studies as an important pedagogy
- Provide rural India and regional agencies with access to the professional resources and expertise of the institutes of higher education
- To improve development outcomes as a consequence of this research

Under UBA, IIT-B and TISS have been appointed coordinating institutions for the Subject Group titled '*Capacity building and change of ethos in technical institutions*'.

The Basic Argument

Development Demands

(Civil amenities such as water, energy, transport, etc., livelihoods, SMEs)

↓

Need for Knowledge, New Practices, New Research (UBA)

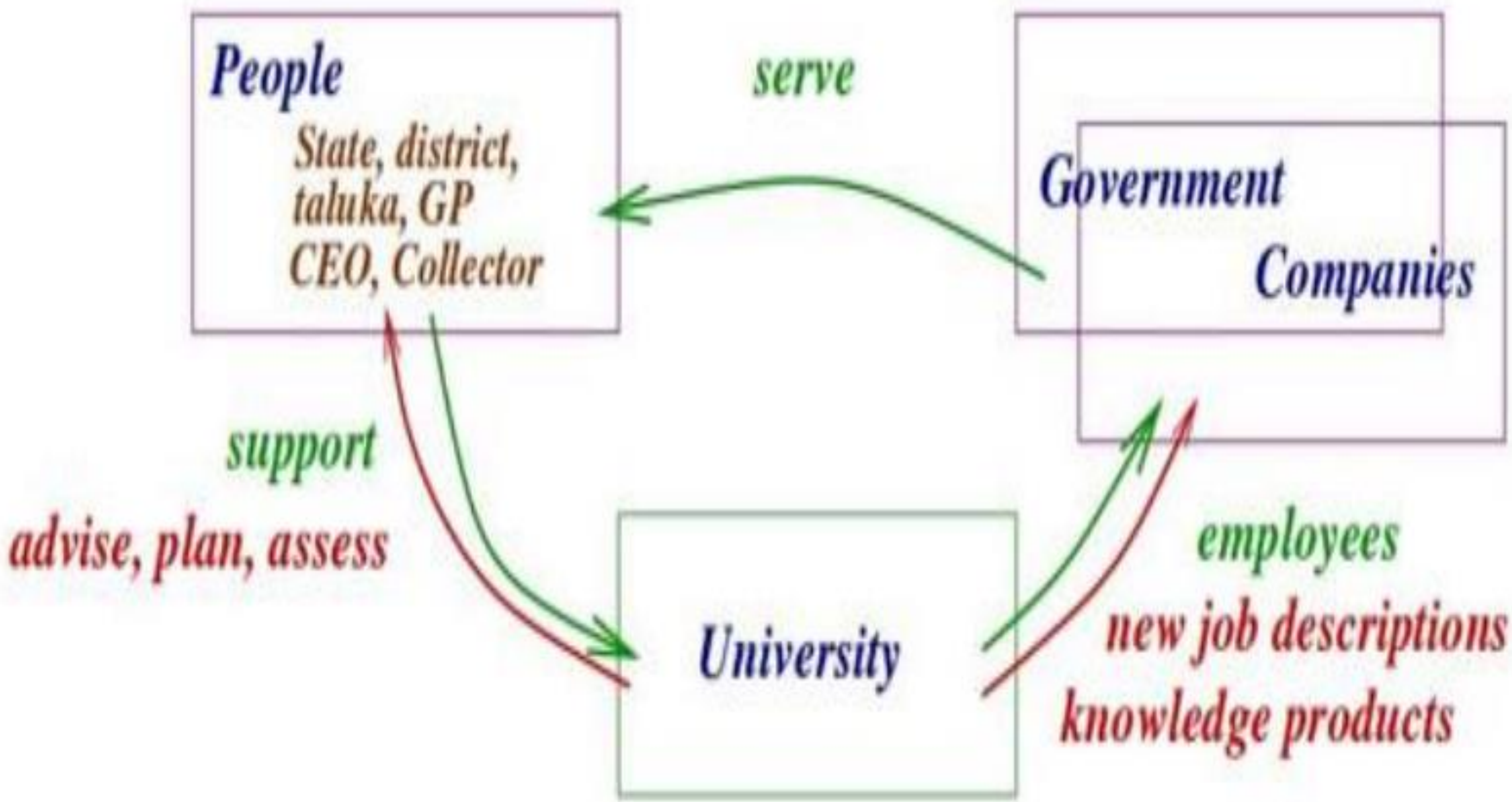
(New Job Profiles, Avenues for Professionals)

↓

The Role of University and Higher Education

(Knowledge Structures, Knowledge Practices, Research in Key Areas)

Role of the University



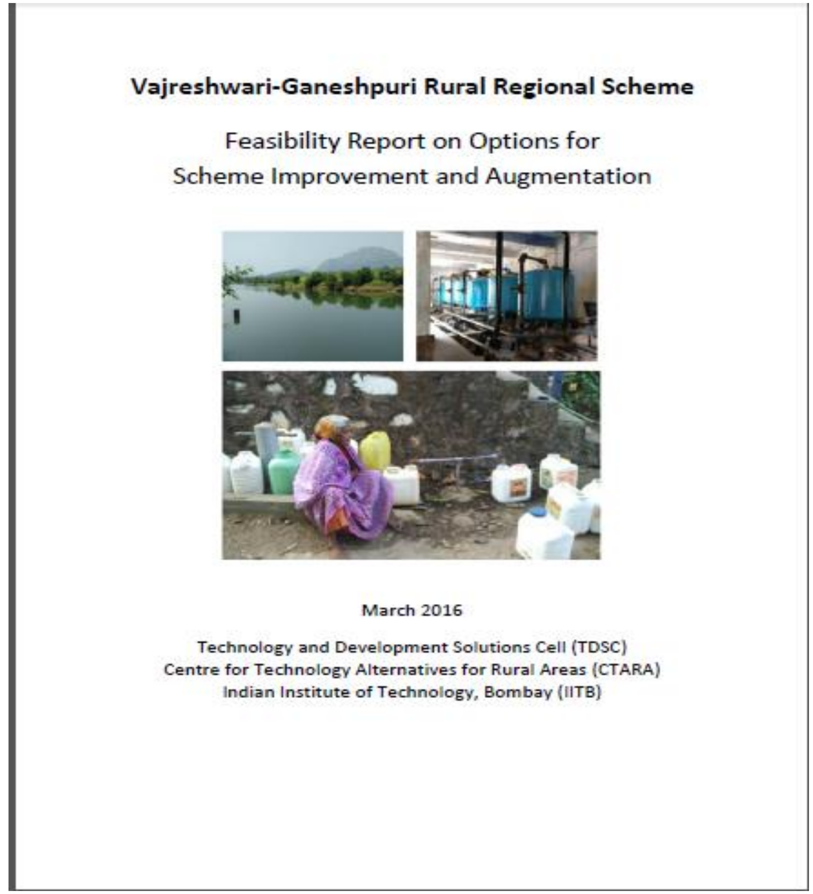
Unnat Maharashtra Abhiyan (UMA) of GoM

- Make institutions regional resources
- Provide mechanism for citizens to approach institutions- *right to knowledge*
- *Provides for data and fees*

At institution level- Phase I

- Allows students to do projects in core areas- *demand driven*

  Analyze failed water supply scheme, do a taluka level water balance, support local industry


Vajreshwari-Ganeshpuri Rural Regional Scheme

Feasibility Report on Options for
Scheme Improvement and Augmentation

March 2016

Technology and Development Solutions Cell (TDSC)
Centre for Technology Alternatives for Rural Areas (CTARA)
Indian Institute of Technology, Bombay (IITB)

UMA/UBA: A Mechanism

- UMA/UBA: A Mechanism to Implement Development Engineering Approach
- What does it need?
- Academic freedom for (i) institutions to offer regional projects and (ii) develop regional areas of expertise
- Skills and training (i) interdisciplinary skills (ii) applied social science (iii) fieldwork (iv) reporting (v) data
- Incentives for faculty and reporting avenues

Recommendations

- Departmental Developmental Areas (Each Department)
- Student Projects in Development (3-9 credits)
- Development Cell (Under Dean R&D)
- Development Engineering Core (3 credits)
- Regional Engineering Core (3 credits)
- Creating Space for Electives and Minors (up to 15 credits)
- Planning as a Minor (up to 15 credits)

Departmental Developmental Areas

- Each core department to identify 2 or more developmental areas for action research, which will have an impact on the ultimate beneficiaries (households)
- Develop 5-10 concrete case-studies every year in each area, done by students through for-credit projects
- Examples of such areas are drinking water, cooking energy, rural electrification, village sanitation plans, rural public transport

Project Areas

- For a comprehensive list of possible project topics and guidelines governing terms of payment and engagement, please visit our website – http://ctara.iitb.ac.in/tdsc/uma/index.html.

Broad Area	Type of service	Case study	Fees	Possible Core Departments
Rural Electricity	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

Project Areas

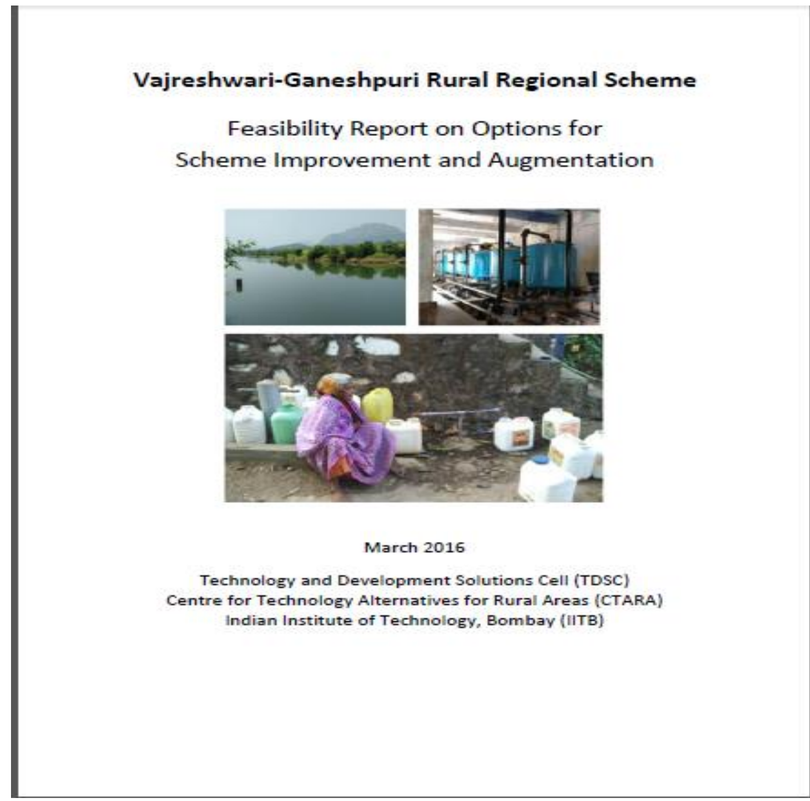
Resources	Logistics and planning	Groundwater utilization and regulation for a specific situation	4-8 man months	Civil, Mechanical, Chemical
	Feasibility assessment and design	Assessment and design of watershed programs such as JYS or IWMP	1-1.5% of plan cost	Civil, Env. Sci. and Engg.
Irrigation	Feasibility 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
Rural industries	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

Student Projects in Development

- Student teams across departments to undertake inter-disciplinary regional field projects
- Field-work to be supervised by faculty members and coordinators
- Reports graded on quality and utility and released in the public domain
- Findings to be discussed with stakeholders

Technology and Development Supervised Learning (TDSL)

Centre for Technology Alternatives for Rural Areas (CTARA)
Indian Institute of Technology Bombay



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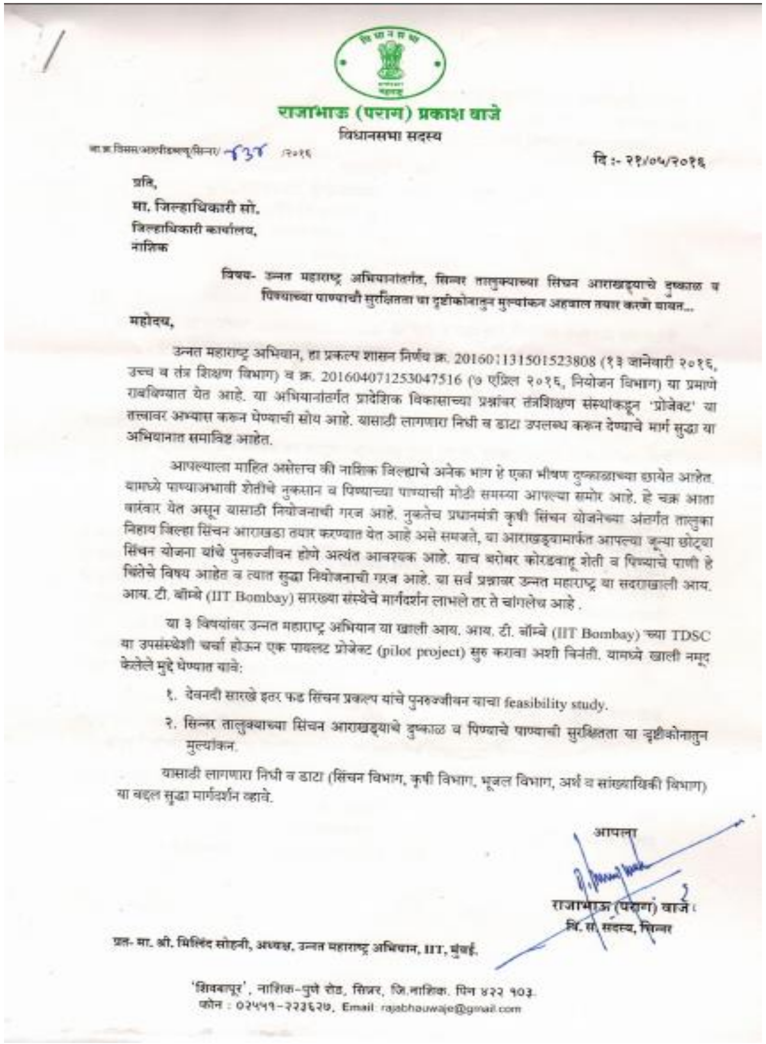
Development Cell

- Institute-wide extension cell which will respond to written requests for advice and analysis from elected representatives and state and local agencies
- Case-Studies as key mechanism- water, energy, urban and rural planning, public transport
- Identification of sources of funding for travel, stay, logistics, data and coordination



राजाभाऊ (पराग) प्रकाश वाजे
विधानसभा सदस्य

जा.क्र.विसस/आरपीडब्ल्यू/सिन्नर/ ६३४ /२०१६

दि :- २१/०५/२०१६

प्रति,
मा. जिल्हाधिकारी सो.
जिल्हाधिकारी कार्यालय,
नाशिक

विषय- उन्नत महाराष्ट्र अभियानांतर्गत, सिन्नर तालुक्याच्या सिंचन आराखड्याचे दुष्काळ व पिण्याच्या पाण्याची सुरक्षितता या दृष्टीकोनातुन मुल्यांकन अहवाल तयार करणे बाबत...

महोदय,

उन्नत महाराष्ट्र अभियान, हा प्रकल्प शासन निर्णय क्र. 201601131501523808 (१३ जानेवारी २०१६, उच्च व तंत्र शिक्षण विभाग) व क्र. 201604071253047516 (७ एप्रिल २०१६, नियोजन विभाग) या प्रमाणे राबविण्यात येत आहे. या अभियानांतर्गत प्रादेशिक विकासाच्या प्रश्नांवर तंत्रशिक्षण संस्थांकडून 'प्रोजेक्ट' या तत्वावर अभ्यास करून घेण्याची सोय आहे. यासाठी लागणारा निधी व डाटा उपलब्ध करून देण्याचे मार्ग सुद्धा या अभियानात समाविष्ट आहेत.

आपल्याला माहित असेलच की नाशिक जिल्ह्याचे अनेक भाग हे एका भीषण दुष्काळाच्या छायेत आहेत. यामध्ये पाण्याअभावी शेतीचे नुकसान व पिण्याच्या पाण्याची मोठी समस्या आपल्या समोर आहे. हे चक्र आता वारंवार येत असून यासाठी नियोजनाची गरज आहे. नुकतेच प्रधानमंत्री कृषी सिंचन योजनेच्या अंतर्गत तालुका निहाय जिल्हा सिंचन आराखडा तयार करण्यात येत आहे असे समजते, या आराखड्यामार्फत आपल्या जून्या छोट्या सिंचन योजना यांचे पुनरुज्जीवन होणे अत्यंत आवश्यक आहे. याच बरोबर कोरडवाहू शेती व पिण्याचे पाणी हे चिंतेचे विषय आहेत व त्यात सुद्धा नियोजनाची गरज आहे. या सर्व प्रश्नावर उन्नत महाराष्ट्र या सदराखाली आय. आय. टी. बॉम्बे (IIT Bombay) सारख्या संस्थेचे मार्गदर्शन लाभले तर ते चांगलेच आहे .

या ३ विषयांवर उन्नत महाराष्ट्र अभियान या खाली आय. आय. टी. बॉम्बे (IIT Bombay) च्या TDSC या उपसंस्थेशी चर्चा होऊन एक पायलट प्रोजेक्ट (pilot project) सुरु करावा अशी विनंती. यामध्ये खाली नमूद केलेले मुद्दे घेण्यात यावे:

१. देवनदी सारखे इतर फड सिंचन प्रकल्प यांचे पुनरुज्जीवन याचा feasibility study.
२. सिन्नर तालुक्याच्या सिंचन आराखड्याचे दुष्काळ व पिण्याचे पाण्याची सुरक्षितता या दृष्टीकोनातुन मुल्यांकन.

यासाठी लागणारा निधी व डाटा (सिंचन विभाग, कृषी विभाग, भूजल विभाग, अर्थ व सांख्यिकी विभाग) या बद्दल सुद्धा मार्गदर्शन व्हावे.

आपला

राजाभाऊ (पराग) वाजे
वि. स. सदस्य, सिन्नर

प्रत- मा. श्री. मिलिंद सोहनी, अध्यक्ष, उन्नत महाराष्ट्र अभियान, IIT, मुंबई.

'शिवबापूर', नाशिक-पुणे रोड, सिन्नर, जि.नाशिक. पिन ४२२ १०३.
फोन : ०२५५१-२२३६२७, Email: rajabhauwaje@gmail.com

Development Engineering Core

- Inter-disciplinarity is the key skill requirement (engineering + social sciences such as economics, sociology, anthropology, history, political science/civics)
- Course structure-
  - Governance structure (at district and taluka level)
  - Field work and reporting
  - Data (GIS, Census Data)
  - Introduction to a specific sector and state processes
  - Cap-stone

Regional Engineering Core

- Focus on an engineering service of regional importance such as Irrigation Water for central Maharashtra, or Food Processing in coastal Maharashtra, or Hill Roads and Bridges for Himachal Pradesh
- *Planning- resources, allocation, attributes*
- CTARA, IIT-B offers a course on Water and Development (TD603)

Creating Space for Electives

Mechanical engineering-

	AICTE	UNIV OF ILL[1]	NUS[2]	IIT-D[3]	COEP
Basic Engg and Sci	60 (34.1%)	29 (22.66%)	28 (17.5%)	51 (33.55%)	50 (27.78%)
Humanities and SS	14 (7.95%)	18 (14%)	20 (12.5%)	15 (9.87%)	9 (5%)
Core	50 (28.41%)	52 (40.63%)	54 (33.75%)	64 (42.1%)	85 (47.22%)
Core Electives	20 (11.36%)	19 (14.84%)	15 (9.38%)	12 (7.89%)	9 (5%)
Open Electives	12 (6.82%)	6 (4.69%)	20 (12.5%)	10 (6.58%)	12 (6.67%)
Others	Project and Internship- 20 (11.36%)	Principles of Composition (Writing)- 4 (3.13%)	Project and Industry- 23 (14.38%)		Project and Seminar- 15 (8.33%)
Total	176	128 + 20 (minor)	160	152	180

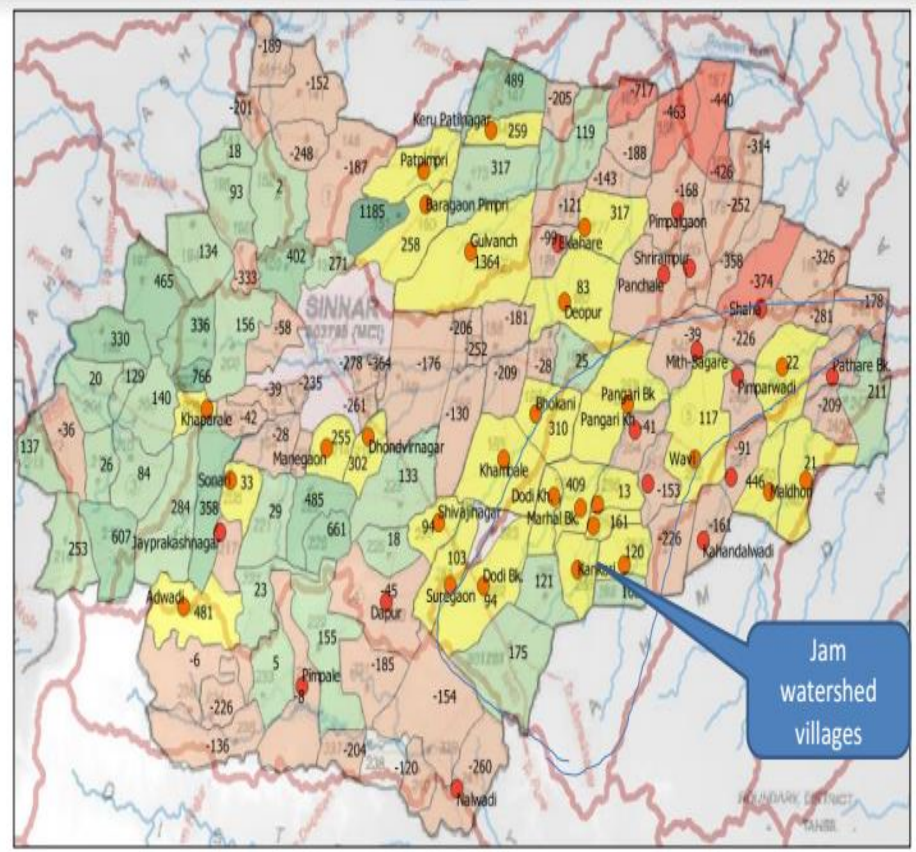
Electrical engineering-

	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 Compositio n (Writing)-4 (3.13%)	Project and Industry-28 (17.5%)		Project- 14 (7.9%)
Total	176	128 + 20 (minor)	160	150	177

Planning

- Traditional-Spatial, natural resources
- Engineering services and supply chains- drinking water, cooking energy, PDS, irrigation, water
- The supply side- natural + infrastructure
- The demand side- human and natural ecosystems, development, aspirations
- Allocation- who gets what and why, laws, economics, efficiency

Synergy between engineering and planning



What do we see

- Interesting minors–geography, planning, economics
- Broader set of skills in non-engineering areas, more professional
- Skills of life-long learning instead of a long list of courses

Recommendations Again

- Departmental Developmental Areas (Each Department)
- Student Projects in Development (3–9 credits)
- Development Cell (Under Dean AP or Dean R&D)
- Development Engineering Core (3 credits)
- Regional Engineering Core (3 credits)
- Creating Space for Electives and Minors (up to 15 credits)
- Planning as a Minor (up to 15 credits)

Possible Outcomes

- For the IITs- connection with real problems, improvement in research, better connect with regional institutions
  - Outside chance of more core placements
- For state governments: additional applied research capacity, better evaluations, assessments, work on state programs, state issues
- For regional institutions: real problems, broader scope for innovation, improvement in regional status, better science and engineering for faculty and students
- For students: better training, professional approach, new avenues for jobs and innovation
- For society at large: access, right to knowledge, better outcomes

Consistency with International Standards

- The engineer is widely recognized as a social and cultural actor and a change-agent. This is reflected in international norms and standards such as the Washington Accord and ABET. The recommendations put forth today are consistent with Washington Accord and ABET guidelines, as are the international undergraduate engineering programs.

Washington Accord

- Washington Accord recommends a curriculum and processes suited to societal needs
- Attribute WA3 of the Washington Accord: ‘Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.’

ABET
(continued on next slide)

GENERAL CRITERION 3. STUDENT OUTCOMES

The program must have documented student outcomes that prepare graduates to attain the program educational objectives.

Student outcomes are outcomes (a) through (k) plus any additional outcomes that may be articulated by the program.

(a) an ability to apply knowledge of mathematics, science, and engineering

(b) an ability to design and conduct experiments, as well as to analyze and interpret data

(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

(d) an ability to function on multidisciplinary teams

(e) an ability to identify, formulate, and solve engineering problems

ABET

(f) an understanding of professional and ethical responsibility

(g) an ability to communicate effectively

(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

(i) a recognition of the need for, and an ability to engage in life-long learning

(j) a knowledge of contemporary issues

(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Expenditure

- The implementation of the above will need an additional expenditure of about Rs.13,000 per student, as indicated in the table below.

Expenditure Estimate per student	
Development Project-TA, DA and expenses	Rs. 4000
2 Field Visits for Development Engg. Core	Rs. 3000
3 Field visits for regional Engg. Core	Rs. 4500
Coordination and Teaching Assistant Expenses	Rs. 1500
Total	Rs. 13000

Measurement and Reporting

- Preparation of departmental areas, reports and case-studies, and regular updating of the website
- Good reports to be counted as research output, creation of a separate Development Engineering journal
- Student and faculty time accounting
- Creation of a Development Cell (T&DC) modelled on the TDSC- will maintain a website containing typical project documents and output, and prepare an annual report
- Each department to maintain a webpage for Development Engineering Core

References

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- CTARA. http://www.ctara.iitb.ac.in/
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- TDSL- Technology and Development Supervised Learning. http://www.ctara.iitb.ac.in/tdsl/
- TDSC – Technology and Development Solutions Cell. http://www.ctara.iitb.ac.in/tdsc/
- TD603- Water and Development. https://www.cse.iitb.ac.in/~sohoni/TD603/

Thank you!