1. Rooting Frugality in Science and Engineering

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In recent years, the concept of frugality, with its origins mainly in India followed by China, has caught on in the rich world (The Economist, 2010). Frugality has been associated with engineering and innovations and has been touted as a significant tool for creating low cost products and services in an era beset by crises including planetary ones such as climate-change and resource scarcity (Rao, 2013). Numerous products in sectors ranging from teaching and healthcare to applications in space have been realized with an eye for lowering costs through a “no frills” structure (Rao, 2013). Examples include the production of low cost products such as the Nano® car and Swach® filters for potable water by the Indian conglomerate Tata Sons and also a no frills refrigerator called chotu Kool® by yet another Indian business house called Godrej & Boyce. Other than products showcased by Indian business titans, developed countries are also jumping into the frugal band wagon as is evidenced by handheld electrocardiograms and portable ultrasound scanners developed by General Electric of the US and also the square kilometer array in South Africa built from nonoperational communications antenna retrofitted into a radio telescope for peering into space. Besides frugality China is also actively applying the principles of mass production to innovations, where an innovative activity is broken down into a series of steps with clusters of experts attacking the idea at a given step (The Economist, 2014). This has led to the production of more innovation in lesser time.

Although frugality and other concepts such as mass production of innovations lend themselves to sustainable solutions for tackling the crises of our times, the act of indulging in these innovations has to be tempered with their detailed knowledge. In other words, frugal
innovations and other creative ideas, have to be firmly supported on the sound principles of science and engineering. Such an association would not only endear these ideas in critical sectors such as health care and aviation but also rope in the private sector and other entities to increase their market share for commercial products.

Therefore, this effort will focus on deepening the association between frugal innovations and science and engineering and thereby make the Jugaad concept more than a makeshift arrangement. In so doing, this work will examine the current state of the involvement of scientific principles and how this could be improved beyond some makeshift arrangements of Jugaad. In particular, existing scientific methodologies will be examined for their use in making frugal innovations of superior quality. This will involve combing for scientific measures that are popular in engineering for capturing both the performance and integrity of frugal products. In fact, weaving science around these innovations would make them amenable to the myriads of approaches available in engineering literature for the systematic realization of these innovations into quality products. The need for injecting more science and engineering into frugal innovations is crucial from the perspective of a possible explosion in the numbers of such products in the foreseeable future and the consequent “cross talk” resulting between many of these frugal products. It should be noted that, notwithstanding the focus on frugal innovations, the findings of this effort are applicable to other newer innovative concepts as well.

2.
Farmer Participatory Research Approach in Farm Mechanization
Er M D Vora

A comparative demonstration-cum-research trial of crop harvesting equipment was conducted on farmer’s field. The manual harvesting of fodder crop by using local sickles was conducted by farmer himself which consumed manpower equivalent to about 27 to 28 man-days for harvesting of 1 ha area of fodder (Sorghum) crop. A self powered smaller sized reaper was hired by the farmer from the nearby place. The time taken by it was 1.2 days/ha and cost 60% higher (as charged by service provider) than the manual cost calculated on basis of prevailing labor rates. Mini-tractor front mounted reaper was provided by the college to conduct harvesting of fodder (sorghum). It took 0.6 days for harvesting of 1 ha and cost 60% less (actual cost incurred) than the cost as in manual method. The results obtained were compared to draw conclusions for the convenience and benefit of farmers in terms of manpower required and percent change of cost in conventional (manual) method. As costs in terms of currency keeps on changing continuously, the comparison of costs in terms of manpower requirement paved way for generating a standing nature of recommendation for the benefit of farming community which can last for longer duration until recommended technology become obsolete. The conclusion drawn from the results of comparison indicated that hourly machine capacity of harvesting by self powered and mini-tractor operated reapers were equivalent to the 18 to 23 and 35 to 45 human-hours respectively.

(Key words: farm mechanization, mechanical crop harvesting, reaper)
3.

**Accelerating Technology Innovations in Institutions of Higher Learning**

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Synergy between education and research has been amply emphasised by the National Knowledge Commission in its report to the Nation in 2007. The institutions of higher learning in India are sitting on the goldmine of opportunity to cause innovations in plenty on the strength of the creative ability of its talented students and faculty. What is needed is the enabling environment in which the mind is focused on industry and society relevant research and innovations involving the creative student community even though they are for their UG studies. It requires percolating the culture of research and innovations right down to UG levels as creative research requires not much financial support and innovations acknowledge no age or qualification.

The Paper presents the strategic framework for accelerating innovations in Universities of Technology and Colleges of Engineering. A few case studies of success story at Delhi Technological University and Amity University Haryana are presented. Today in Indian context, the technological innovations are success key for high economic growth, skilled manpower, world class infrastructure and high job potential. Knowledge exchange between higher education institutions and the R&D and manufacturing industry plays vital role in overall growth of the country. Amity University Haryana has been taking steady progress to promote research and technological innovations. It has developed technology park and technology incubators. Such activities promote R&D environment and students are often heard of discussing and focussing on new products and patenting ideas. New minds pushes faculty to think on more innovative and alternative approaches for not so efficient systems seen around. Alternative more efficient and more economical systems are in creation stages it any field of engineering and sciences. Some case studies are reported in the present paper.

4.

**Factors Explaining Students’ Inclination towards Entrepreneurship: Empirical Study of Ethiopian University Students**

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This study investigates the inclination towards entrepreneurship among university students in Ethiopia. Specifically, it aims to examine the relationship between entrepreneurship education and inclination towards entrepreneurship. The influence of demographic characteristics and family business background on university students’ inclination towards entrepreneurship is also being examined. An empirical test carried out on the data gathered from questionnaires demonstrates that two entrepreneurship education variables are found to have statistically significant relationship on the inclination towards entrepreneurship. At the
meantime, two demographic variables and a family business background variable have an
effect on university students’ inclination towards entrepreneurship. Finally, based on the
findings, the implications of the study have been forwarded.

**Keywords:** Entrepreneurship education; inclination towards entrepreneurship; demographic
characteristics; family business background; University students

5.

**Characterizing the grassroots innovation process, to develop value-driven case studies for engineering pedagogy**

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Design and engineering can play a critical role in solving everyday problems of the large 'base of the societal pyramid' in India. However, our engineering education system grooms students primarily for industrial roles. Since grassroots problems do not form the mainstream concerns of industry and business, most engineering programs do not require students to engage with the complexities of rural, grassroots problems, and the sustainability and social issues embedded within them. Technology education does not sufficiently equip students to deal with such problems. Given this orientation of the education system, few students are motivated to grapple with grassroots problems. Recent engineering education research highlights this state of affairs, and calls for reforms to curricula and pedagogy, so that students are encouraged and equipped to address complex societal and sustainability problems.

The study of practitioners is an emerging approach to developing such real-world-focused curricula and pedagogy. A limitation of this approach currently is that it mostly explores the practice of formally trained engineers, who tend to work on modularized problems, where (the mostly externalized) sustainability and social issues are not clearly and fully visible to the practitioner. Further, everyday problems faced by the rural population are rarely addressed by formal engineering practice.

A more productive approach to embedding pressing real-world problems and sustainability issues in Indian curricula and pedagogy would be to understand design in the “wild”, by developing rich case studies of the many technologies developed by rural innovators in India. Such a study would help make explicit, in an integrated fashion, two core value aspects missing from current engineering education: 1) epistemic and cognitive values needed for situated problem-solving at the grassroots context, and 2) identities that would allow students to examine and choose different ways of using their knowledge (such as social entrepreneurship, development consultancy, sustainability engineering etc.).

Our study follows this approach, seeking to characterize the non-formal practice of successful grassroots innovators identified by the National Innovation Foundation, particularly their design principles and cognitive practices. The objective is to develop detailed case studies of
these innovations and the cognitive practices of the innovators, such that the case studies could be integrated into the engineering design curricula. These cases may also provide a way for students and grassroots innovators to work together at the level of class and course projects.

To better situate the cases, this study will be contrasted with parallel case studies of formally trained engineers solving similar problems.

In this paper, we present our preliminary observations from an empirical study of a grassroots innovator's and a group of engineering students' practice of developing a micro hydro turbine, as a part of this larger study.

Keywords: building; case study; concept integration; design; engineering; equity; grassroots innovators; real-world problems; sustainability; values

6.

LINKING GRASSROOTS INNOVATION WITH TECHNOLOGY AND APPLYING SUSTAINABLE ENVIRONMENTAL TECHNOLOGY TO INDUSTRIALISING GRASSROOTS INNOVATION

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Zimbabwe is awash with grassroots innovations which have not been tapped to provide sound sustainable technological development in Zimbabwe. Basically in Zimbabwe, current approaches in technological innovation have constantly taken an approach of up-down which often does not really articulate to local problems and as a result are not well received by the communities. At the same time the research and academic institutions which are supposed to incubate and articulate them to local terrain have limited influence and hence become largely irrelevant and result in limited impact. For grassroots technologies to be locally relevant, research and academic institution should take a leading role in incubating and commercializing grass roots technology. They should provide the link between the industry and the communities from which grassroots technology comes from. This paper explores the potential of linking grassroots innovations with technology and applying sustainable environmental technology to industrializing grassroots innovation in Zimbabwe. The paper further examines the potential of grassroots realization through international collaboration and the aspects of patenting at an international stage.

Key words: grassroots, technology, sustainable, collaboration, implementation and environment
There is the need for dynamism in higher education, research and innovation in India due to changing lifelong learning needs, growing Communication and Information Technology usage and enhanced networking and social engagements, both with the economic sector and community at large, which have become strategically interlinked in terms of their objectives and modalities. The widening gap between basic and applied research is dominating the challenge of “think global and act local”, necessitating flexibility in research systems and pragmatic approaches serving societies in the widest sense. The advent of knowledge society along its principal engine, the knowledge economy and widening “Digital Divide” has shaped the social change resulting in the acceleration in the risks of marginalization. With most of the innovations occurring outside academic environments, the diminishing dividends of Indian higher education with public money at stake has failed to translate the knowledge into innovative actions thus losing competitiveness in the global knowledge society. The need for growing dynamism of “research for innovation” and “research on innovation” with meta-analysis of crucial knowledge systems, the need for growing partnerships between governments, the economic sector and the research institutions so that new knowledge becomes linked to developmental goals has been thoughtfully deliberated in the present paper. Though the analysis focuses on redefining of Indian higher education system, the global trends and future directions are also mentioned therein.

Keywords: Applied research, Knowledge Economy, Digital divide, Innovation.